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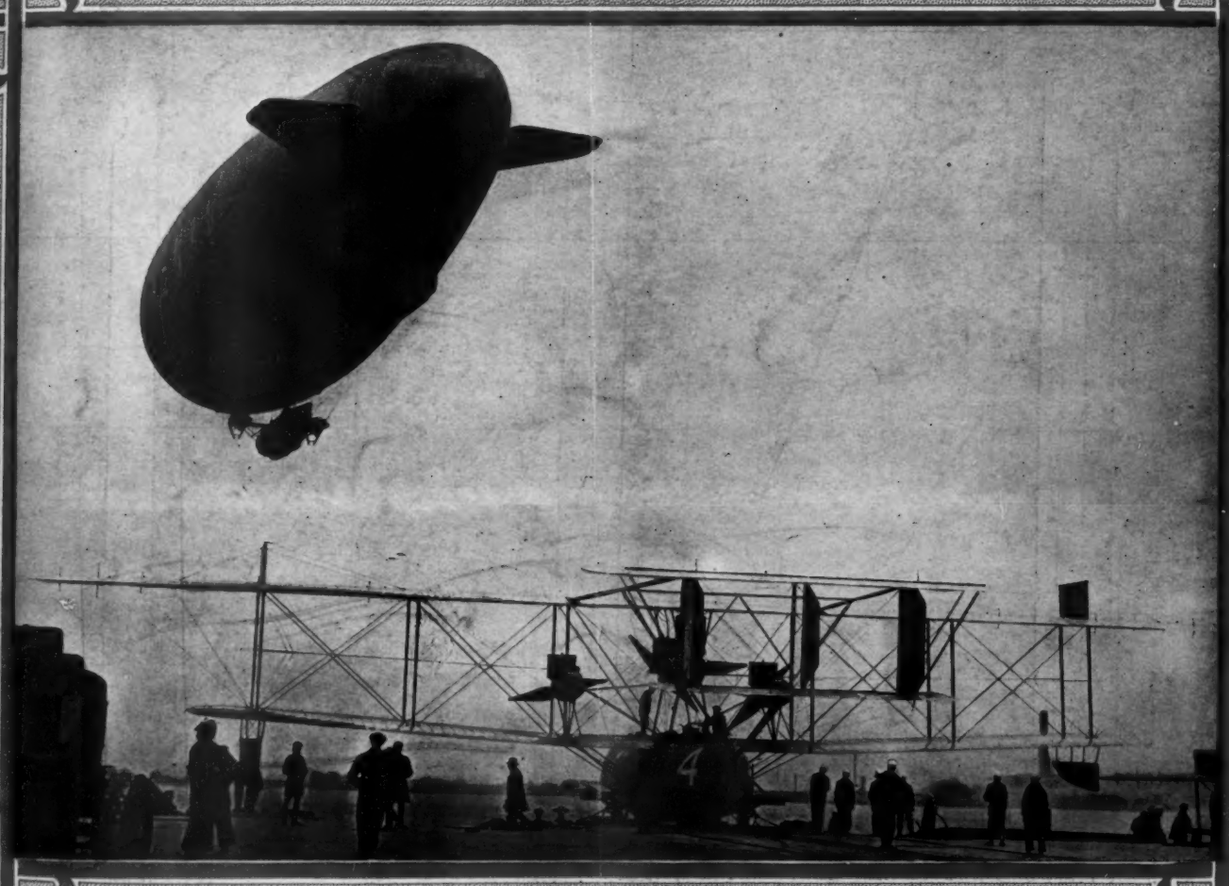

(c) *Paul Thompson* **Naval Airship C-5 Passing Over Naval Seaplane NC-4**

VOLUME VI
Number 8

SPECIAL FEATURES

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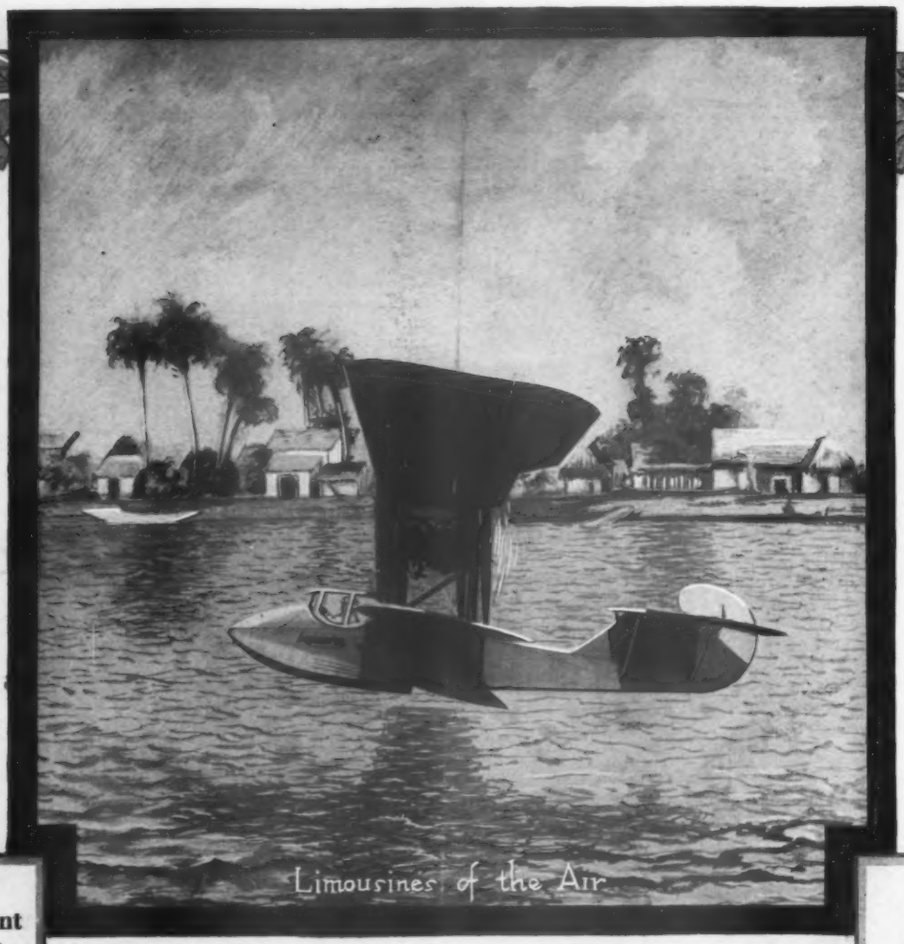

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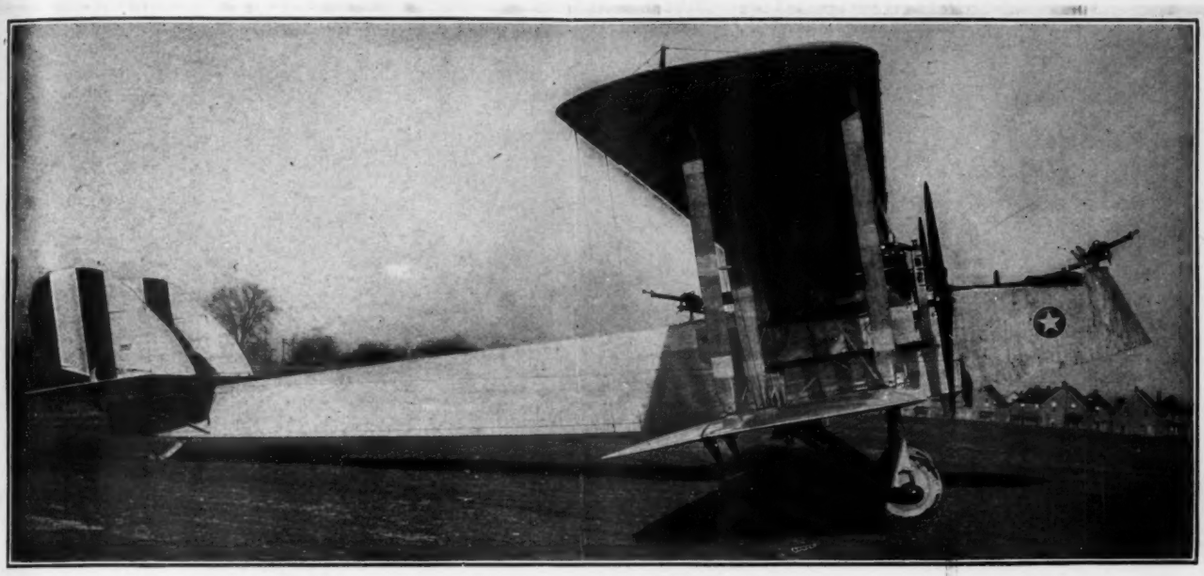

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Major Schroeder gives full credit to the simplified construction, the intense spark and the absolute dependability of the Standardized Aero that nursed his supersensitive engine to a place in the world's records.

It is rumored that he will again this coming summer attempt to lower his own altitude record. And so great is his confidence in the Standardized Aero that the plane he chooses will again be driven by the same magneto which made his previous record breaking flight possible.

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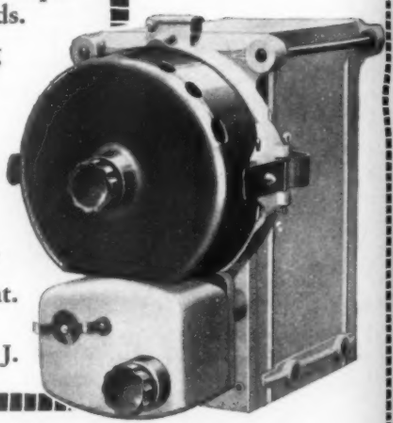

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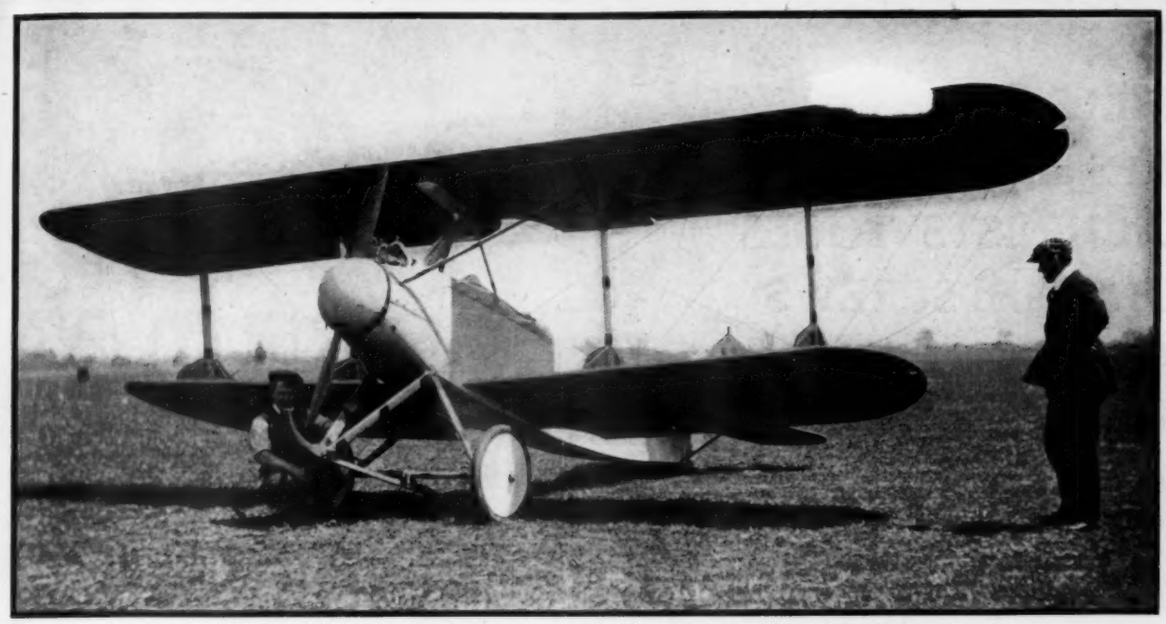

A close-up photograph. Note landing gear and special strut construction affording self-alignment.

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The most encouraging sign of the future of aviation is the large number of former army and navy flyers who are coming back into flying for sport, and as a profession.

The war was responsible for the rapid training of many thousand men—the best blood of the nation—who are generally recognized as the most skillful, resourceful and daring pilots in the world.

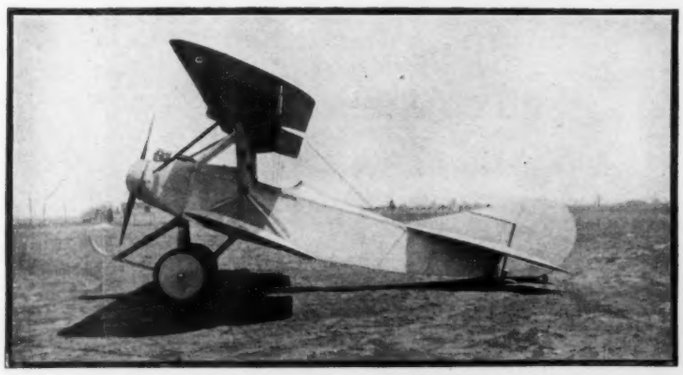
When these men left the service, their interest in flying did not cease. On the contrary, they are more eager to fly than ever before. The call of the air is irresistible. They will fly, henceforward, just as in past years they played polo, and owned speed boats, and rode to hounds, and took part in other man's-size sports and occupations.

For the benefit of these men, and their friends, a group of aeronautic engineers and others keenly interested in aviation foresaw the tremendous present-day need for a reliable and practical light airplane, and have proceeded to build and test a plane that would meet these requirements.

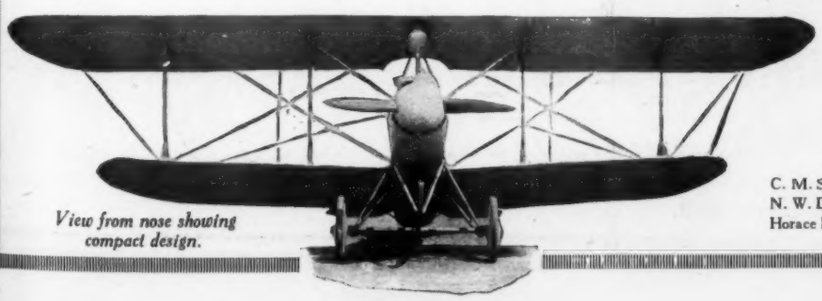
This plane is The Ace. It is ready for you now.

Write for new folder, containing pictures and specifications of The Ace—the first American airplane designed after the war essentially for civilian use—and the most practical and safest small ship ever built for the man who wants to fly frequently, regularly, and at a minimum of expense.

The Ace taking off. Lt. Murchie, pilot.



Outside hangar, ready for daily flight.



View from nose showing compact design.

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MAY 15, 1919

AVIATION AND AERONAUTICAL ENGINEERING

VOL. VI. NO. 8

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BUSINESS MANAGER

Vol. VI | May 15, 1919 | No. 8

The successful completion, by two of the three machines forming NC Seaplane Division 1, under the command of Comdr. John H. Towers, U. S. N., of the 1000-mile cruise from Rockaway naval air station to Trepassey, N. F., augurs well for the outcome of the transatlantic flight attempt of the United States Navy.

Despite atmospheric conditions which were on the whole decidedly unfavorable to such a long-distance flight and must have put the mechanical as well as human element to a considerable strain, the two NC seaplanes accomplished the initial part of their great journey without any serious delay and reached their appointed starting place in fully serviceable condition. This cruise furnishes convincing evidence of the fact that the multi-engine flying boats upon which the Navy bases its faith for being the first to cross the Atlantic by the aerial route are, notwithstanding the comparative novelty of their design, by no means experimental machines, but are, on the contrary, fully qualified to undergo that crucial test of efficiency represented by the oceanic flight.

It seems particularly fitting that this country should be represented in the transatlantic flight competition by seaplanes of the boat type, which are a typically American development—even more so perhaps than the airplane. Indeed, the latter, after having been invented in this country, was mainly perfected in Europe, whereas the seaplane owes virtually its entire progression from the feeble attempts at making an airplane float on a canoe-like structure to the 14-ton flying boats which are to carry the Stars and Stripes across the Atlantic to American inventive faculty and scientific achievement, and more particularly to one man among so many other contributors to the art of marine flying—Glenn H. Curtiss.

It was Curtiss who, some eight years ago, built the first float type seaplane that proved its practicability by repeatedly rising from and alighting on the surface of the sea at San Diego. It was he again who, realizing the drawbacks of this type for sea service, created the following year the boat type seaplane, or flying boat, which by the substitution of a boat like hull insures greater seaworthiness than the "floating airplane"—a landsman's conception. Finally, when it became evident that the difficulties of open sea could be overcome only by a considerable increase in size, it was again Curtiss who did pioneer work in developing the first twin-engine flying boat, the America, which was incidentally destined to cross the Atlantic.

The America opened a new era in the history of marine flying, for this craft was the forerunner of the huge multi-engine flying boats which have so well proven their worth in the Great War, and may also be considered as the ancestor of the NC seaplanes, in whose initials the names of the Navy and of Curtiss are united.

Therefore such triumph as all Americans fervently hope will befall the NC seaplanes on their journey across the Atlantic may truly be called an All-American victory.

Ground School and Flying Instruction

A recent enquiry from a prospective flying student referred to a school where both ground school work and flying work would be included. No such school seemed to be available. Prior to the war the very term ground school work was unknown and a flying school meant purely and simply a school where flying was taught.

The old tacit theory was that, on the whole, the less a pilot knew of aerodynamics and theory the better, and that he ought to know no more about his machine than to make him an aerial chauffeur. This may possibly apply to the pilot who takes up flying as a pleasant sport, but such a training will not suffice at all for the professional pilot who wishes to make flying his life's work. The more ground school training such a man absorbs the better equipped he will be as a professional pilot.

From the engine standpoint, he will handle his machine much better in the air, if he understands what the engine really is, if he can make intelligent observations of its behavior in the air, study it as the interesting and complicated mechanism that it is, be able to judge how well the mechanics have tuned it for him, and in case of need, due to a forced landing in cross-country work be able to make such minor repairs as may save valuable time and enable him to continue his journey.

It is the man who goes up in the plane who is most interested in knowing that the plane is rigged just right, that all the controls are properly adjusted, that the machine is well balanced. A knowledge of Rigging and Principles of Flight will make a much better critic on this score and serve as a check on designers.

With the increasing length of cross-country flying the pilot must be able to understand wireless and the wireless direction finder, and have a fair acquaintance with the principles of navigation. Later on he will probably even have to possess a working knowledge of Federal or State regulations.

The increasing complexity of his job will be a decided benefit to the pilot and raise his status from that of an aerial chauffeur to that of an air navigator ranking with the captains and mates of seagoing vessels.

Naval Transatlantic Flight Expedition

The transatlantic flight expedition of the United States Navy, consisting of seaplanes NC-1, NC-3 and NC-4, under the command of Commander John H. Towers, U. S. N., took off on May 8 at Rockaway naval air station, en route for Halifax, N. S., the first point of stoppage designated in their flight to Newfoundland. The trans-Atlantic flight proper will begin only at Trepassey, N. F., a distance of 1,000 nautical miles (1,150 Sta. miles) from Rockaway.

The three seaplanes started at 10 a.m. with the following crews:

N. C. 3—Flagship.

Commanding officer—Comdr. John H. Towers, commanding officer of the NC Seaplane Division 1.

Pilot — Comdr. H. C. Richardson.

Pilot—Lieut. David H. McCullough.

Radio operator — Lieut. Comdr. R. A. Lavender.

Engineer—Machinist L. R. Moore.

Reserve pilot—Lieut. Braxton Rhodes, to go as far as Newfoundland.

Navigating instrument expert—Lieut. Comdr. R. E. Byrd, (to go as far as Newfoundland).

N. C. 1

Commanding officer—Lieut. Comdr. P. N. L. Bellinger.

Pilot—Lieut. Comdr. M. A. Mitsher.

Pilot—Lieut. L. T. Barin.

Radio operator — Lieut. Harry Sadenwater.

Engineer — Chief Machinist's Mate C. I. Kesler.

Reserve pilot — Machinist Rasmus Christensen, Newfoundland only.

Experimental officer—Ensign C. J. McCarthy (Newfoundland only.)

N. C. 4

Commanding officer—Lieut. Comdr. A. C. Read.

Pilot—Lieut. E. F. Stone.

Pilot—W. K. Hinton.

Radio operator—Ensign R. C. Rodd.

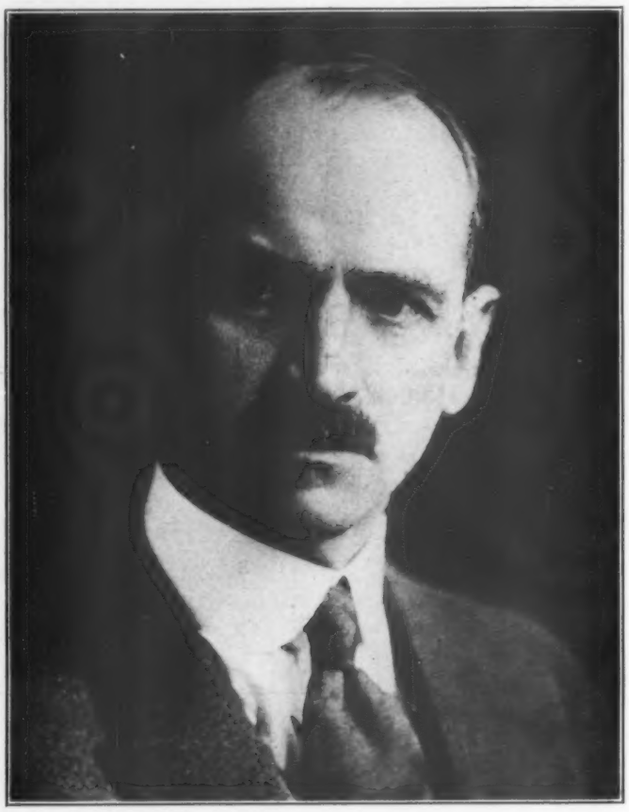
Engineer—Chief Machinist's Mate E. S. Rhoads.

Reserve pilot—Lieut. J. L. Breese (Newfoundland only.)

Seaplanes NC-3 and NC-1 alighted in Halifax Harbor at 6:55 p.m. New York time, having thus covered the total distance of 540 nautical miles (621 Sta. miles) in 8 hr. 55 min., without any untoward incident. The NC-4 was not so fortunate, however, for engine trouble developed on board off the Maine coast and compelled the seaplane to alight, whence she taxied into Chatham naval air station.

On May 10 the NC-3 and the NC-1 concluded their flight to Newfoundland by covering the distance of 460 nautical miles (621 Sta. miles) separating Halifax from Trepassey, N. F., in seven hours. In the meantime the NC-4 was re-fitted with two new engines and is awaiting favorable weather to join her sister ships in their attempt to cross the Atlantic, which is to take place as soon as the atmospheric conditions warrant it.

The following course has been laid out for the crossing of the Atlantic: (1) from Trepassey to Horta, Island of Fayal, Azores, 1,200 nautical miles (1,380 Sta. miles); or, if conditions are favorable, to Ponta Delgada, Island of San Miguel, Azores, 1,315 nautical miles (1,552 Sta. miles); (2) from Ponta Delgada (115 nautical miles from Horta) to Lisbon, Portugal, 800 nautical miles (920 Sta. miles); and (3) from Lisbon to Plymouth, England, 775 nautical miles (891 Sta. miles). The total distance of the trans-Atlantic flight is to be 4,090 nautical miles (3,743 Sta. miles).



GLENN H. CURTISS, THE PIONEER OF MARINE AVIATION AND ORIGINATOR OF THE FLYING-BOAT

Official Description of the NC Seaplanes

The following description of the NC seaplanes participating in the trans-Atlantic flight, which are all of the same type, was officially given out by the Navy Department:

Wing span from tip to tip, 126 ft.

Upper wing from tip to tip, 114 ft.

Aileron projections beyond wing tips, 6 ft. on either side.

Lower wing span, 94 ft.

Width of wings, 12 ft.

Distance between wings, 14 ft. at center and 12 ft. at outer tips of lower wing.

Over-all length from front end to the rear end, 68 ft. 3½ in.

Length of hull, 44 ft. 9 in.

Wing area, 2,380 sq. ft.

Weight of flying boat (empty), including wireless installation and all navigating instruments, 15,100 lb.

Weight full load flying condition, 28,500 lb.

Percentage of useful load to total load, that is load not a portion of structure or equipment, 47 per cent.

Weight carried per square foot of wing surface, 12 lb.

Estimated speed at full load, 79 nautical miles per hour.

Estimated speed at light load, 84 nautical miles per hour.

Horsepower of four Liberty engines, 1,600 h.p.

Number of gasoline tanks, nine in hull, one in upper wing above boat hull.

Capacity of gasoline tanks, 200 gal. for each hull tank and 90 gal. for gravity feed tank in upper wing.

Weight of gasoline system, 6 lb. per gal. of gasoline.

Weight of engines, 825 lb. each.

Weight of boat hull (empty) 2,650 lb.

Area of ailerons, 265 sq. ft.

Area of stabilizers, 267.6 sq. ft.

Area of elevators, 240.1 sq. ft.

Area of rudders, 69 sq. ft.

Displacement of wing tip pontoons, 1,800 lb. each.

Weight of wing tip pontoons, 95 lb. each.

Gasoline pumps are wind driven by small wooden propellers and are in duplicate; an auxiliary hand-operated gasoline pump is provided.

Flying control is of the dual control Deperdussin system with side-by-side seating.

Pilots are in hull just forward of gasoline tanks.

Complete sets of instruments provided for pilots, including one compass for each pilot.

Navigating station is in front end of boat hull. Navigator is provided with chart board, charts, and ordinary navigating instruments, including compass and sextant.

Complete wireless installation, including telegraph and telephone and wireless direction indicator, is provided. System should give a radius of approximately 300 miles while in the air and of 100 to 150 miles while on the water.

Electric current is furnished by electric generator operated by a wind-driven propellor. Current is delivered to storage batteries. In addition to operating wireless set, storage batteries operate complete lighting system for interior of boat and for wing tip and tail lights as well as lights for night landing.

Wireless operator and engineer are located in main after-compartment just aft of gasoline tanks. Each is provided with complete instrument board. Each of these operators has a cylindrical upholstered stool with back rest weighing 5 pounds complete, in the interior of which can be stored the small hand tools required for emergency work.

Cruising speed of boats, about 72 miles per hour.

Wing covering is linen treated with the ordinary airplane fabric dopes.

Gasoline tanks are of aluminum and gasoline piping is partly of aluminum and partly of copper.

Streamlining forms about wing struts are of Micarta. Streamlining of flying and landing wires is of rubber covered with rubberized fabric.

REAR-ADM. D. W. TAYLOR
(C) *Harris & Ewing, from Paul Thompson*

COMDR. G. C. WESTERVELT
Photo Paul Thompson

COMDR. H. C. RICHARDSON
(C) *Western Newspaper Union*

COMDR. J. C. HUNSAKER
(C) *Harris & Ewing, from Paul Thompson*

Main keels of boat hulls are of oak or of rock elm. Hull structure is in general of spruce. Planking is of spruce or of cedar. Turtle-back covering is of cedar or of cottonwood birch three-ply veneer.

Cowling around engine nacelles is aluminum.

Four liquid fire extinguishers are carried in each boat hull.

START OF NC SEAPLANE DIVISION 1 FROM ROCKAWAY BEACH

(C) *Paul Thompson*

Gasoline consumption at cruising speed, about 650 pounds average per hour.

Total gasoline carried, about 11,400 pounds.

Cruising radius without wind, about 1,476 nautical miles.

Lubricating oil capacity, about 900 pounds.

Crew and provisions, about 1,000 pounds.

Crew, five men—two pilots, one navigator, one wireless operator, and one engineer.

Main structure is of Western spruce.

Metal wing fittings and structural fittings in general are of chrome vanadium steel of an ultimate strength of 150,000 pounds per square inch.

All flying and landing and control wires are of standard woven airplane cord wire.

Access to any portion of the boat hull by means of wing passages or to any portion of the power plant by means of hatches in the boat hull may be had either while on the water or while in the air.

All control surfaces, such as ailerons, rudders, and elevators, are balanced by a portion of the area forward of the pivoting points in order to relieve the work of the pilots.

The NC seaplanes were built to the designs of Comdrs. G. C. Westervelt, H. C. Richardson and J. C. Hunsaker, Construction Corps, U. S. N., with the co-operation of the staff of the Curtiss Engineering Corp., at the plant of the latter firm at Garden City, L. I. The initial trial flights of the first of these boats, the NC-1, took place on Nov 8, 1918, at Washington, D. C.

Trans-Atlantic Flight and Meteorology*

By Willis Ray Gregg

In the foregoing discussion an attempt has been made to present in brief form a general review of average conditions both at the surface and in the free air. A knowledge of these is of interest and importance to an aviator, but should be used with caution, for average conditions seldom occur and they would scarcely ever prevail at all points along a route as great as that from America to Europe. We now come, therefore, to the third part of the paper, namely:

3. *The Assistance of Winds*

In order to determine, under given conditions of wind, the direction toward which an airplane should be headed in order that it may keep to any desired course, and the resultant speed along that course, it is only necessary to resort to that elementary principle of mechanics, applicable to any body moving through a medium which itself is in motion, viz., the principle of the composition of speeds. For example, in fig. 2 let OB represent a course which an aviator

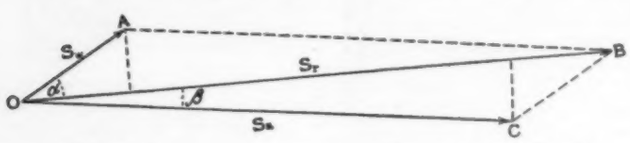


FIG. 2. RESULTANT COURSE AND SPEED OF AIRPLANE

desires to follow, and OA and S_w the speed of the wind, this wind making an angle α with the line OB.

Also, let S_r represent the air speed (i. e., speed in still air) of the airplane.

Then the angle B which the airplane should make with OB, in order that the latter shall be resultant course, may be readily computed, since the sines of the two angles are inversely proportional to the two speeds, or

$$\sin \beta = \frac{S_w \sin \alpha}{S_a}.$$

Also, by completing the parallelogram, we find graphically the resultant speed, or $S_p = S_w \cos \alpha + S_a \cos B$.

To take a typical case, suppose the desired course is E. 5 deg. S.; wind bearing and speed are E. 25 deg. N., 10 m.p.s. (about 22 m.p.h.); and the air speed of the machine is 40 m.p.s. (about 90 m.p.h.). Then $\alpha = 30$ deg.

$$\sin \beta = \frac{10 \times \sin 30 \text{ deg.}}{40} = .1250$$

$$\beta = 7 \text{ deg., or } OC = \text{E. } 12 \text{ deg. S.}$$

Also $S_r = 10 \times \cos 30$ deg. $+ 40 \times \cos 7$ deg
$= 48$ m. p. s., or about 107 m. p. h.

From the foregoing brief discussion, it is evident that, with an airplane of known air speed, the successive directions toward which the machine should be headed and the total distance covered in a given time (or the time required to fly over a given course) are quickly and easily determined, providing the prevailing wind conditions are known. The great difficulty consists in finding out, at any specified time, just what these wind conditions are. This is being done very successfully at a large number of places in this country with kites carrying self-recording instruments known as meteorgraphs and with small rubber "pilot" balloons, whose movements through the air are followed by means of theodolites. The data thus obtained are telegraphed to the Central Office of the Weather Bureau, and bulletins are issued for the information of aviators in the Aerial Mail Service, Army and Navy Air Service, etc. Another method of determining wind conditions that has been used in the war and at ordnance proving grounds, is by means of so-called "Archie" bursts, which consist of puffs of smoke from a shell, the fuse being so timed that the shell bursts at any desired altitude. The movements of these smoke puffs are observed in a graduated mirror and the wind directions and velocities at the given height are readily computed. When low clouds are present several shells are sent above the clouds at stated intervals, usually half a minute apart, an airplane of known speed flies from the first smoke cloud to the last, and the aviator is thus able quite accurately to determine the current wind conditions and to set his compass course accordingly. Still another method used in France during cloudy weather consists in sending up small balloons which carry small charges of melinite so arranged that they burst successively at regular intervals. Sound telemeters record the explosions, and the position in space of the points of detonation can be thus determined. All of these methods are comparatively simple on land; they are less so at sea, yet some of them at least are by no means impossible, except in very stormy conditions. For observations by any of these methods it is advisable that the ship remain as nearly as possible in one position. Hence it would be impracticable, or at any rate difficult, to utilize trans-Atlantic steamships for this purpose. The best scheme would be to have at certain intervals along a proposed route several small ships that could make and report such observations. These ships would also be able, by means of radio communication, to act as guides for an aviator and, in case of accident, to provide a means of rescue. In order to be successful, trans-Atlantic flight, at any rate in its earlier stages, should certainly have the benefit of such assistance. Aside from the uncertainty as to wind conditions there is the added difficulty of keeping to a course, partly because of the deflective influence of the earth's rotation and partly because of lack of precision in the compass itself. With clear skies sextant observations make possible the correct determination of position, but in cloudy weather the compass is the only guide unless the aviator can fly high enough to get above the clouds.

In case free-air observations are unavailable, there still remains the possibility of obtaining reports of surface conditions. Such reports could and should be furnished not only by specially detailed ships but also by those regularly plying between America and European ports. With these observations the meteorologist would be able to draw a synoptic weather map showing the surface conditions of pressure and wind that prevail at a given time, and from this map wind velocities at an altitude of 500 to 1000 meters could be quickly determined usually with fair accuracy, from the well-known equation for gradient winds, viz:

$$v = \sqrt{\frac{r}{\varrho}\frac{dp}{dn} + (r\omega \sin \phi)^2} \pm r\omega \sin \phi,$$

in which v = velocity in centimeters per second,

$\frac{dp}{dn}$ = difference in dynes pressure per square centimeter per centimeter horizontal distance at right angles to isobars,

r = radius of curvature of the isobar at the place of observation, in centimeters,

ϱ = air density in grams per cubic centimeter,

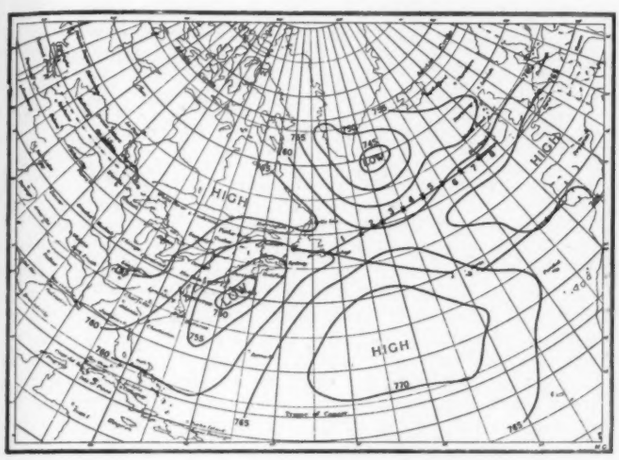
ω = angular velocity of the earth's rotation $= \frac{2\pi}{86164}$

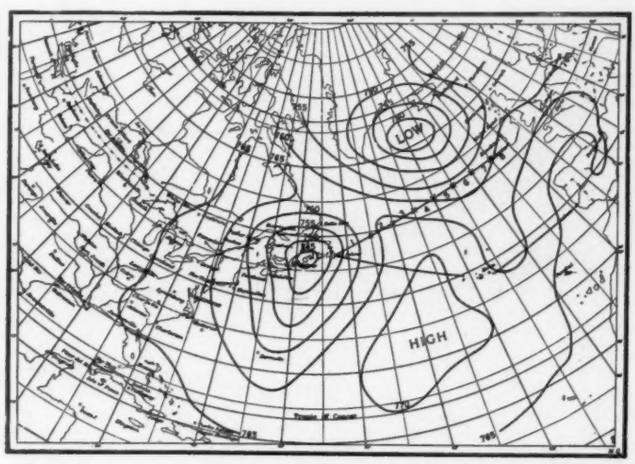
and ϕ = the latitude.

Wind directions at these altitudes are usually found to be very nearly parallel to the isobars. When pressure conditions are well defined and relatively stable, comparatively small error is introduced in accepting the foregoing assumptions, but when they are very irregular or when local disturbances, like thunderstorms, squalls, etc., are occurring, the principle of gradient winds must be used with caution. In general, it is more reliable over ocean than over land surfaces, because, as already pointed out, isobaric systems are larger and move more slowly over the oceans than they do over the continents.

* Excerpt from a paper presented before the Philosophical Society of Washington, March 29, 1919. Concluded from last issue.

It is not sufficient, however, for the aviator to know the *current* wind conditions. He must also be informed as to the *changes* that are likely to occur during the latter part of his trip, and this may be as much as 20 to 25 hours in advance. Here again the meteorologist is assisted by the fact that isobaric systems over the ocean are relatively slow-moving. With this in mind and from a detailed study of the map before him he can construct a series of maps showing expected conditions at intervals of six hours, for example. From this series of maps he is able to determine the probable wind conditions that will prevail at successive points along the course at the times at which the aviator is expected to reach those points, these times being dependent, of course, on the air-speed of the machine and on the assistance furnished by the winds.





FIGS. 3 AND 4. PRESSURE DISTRIBUTION, NORTH ATLANTIC, MAY 29 AND 30, 1906

For the purpose of illustration let us consider a type of pressure distribution that is not uncommon, and endeavor to trace out the wind conditions at an altitude of 500 to 1000 meters along a great circle course from Newfoundland to Ireland. The time selected is the 24-hour period from Greenwich mean noon, May 29, 1906, to the same hour on May 30, 1906. Fig. 3 shows the pressure distribution prevailing at the beginning of this period and fig. 4 shows that prevailing at the end of the period. On these maps are also indicated the great circle courses from Newfoundland to Ireland, and from Newfoundland to Portugal via the Azores. In the study an attempt has been made to trace the changes in the pressure distribution by means of intermediate maps, but these are not reproduced here. The flight is supposed to start from Newfoundland at about 2 p.m., 60th meridian time, or about six hours after the observations charted in fig. 3 were made. About this much time would normally be required for the receipt and interpretation of reports.

Table III gives in some detail the results of this study. The course has been divided into eight sections as indicated by crosses in the figures and these sections are listed in column 1 of the table. Columns 2 and 3 give corresponding bearings and distances; columns 4 and 5 computed gradient wind directions and speed; column 6, the directions toward which the airplane should be headed in order to keep to the courses indicated in column 2; column 7, resultant speeds; and column 8, the time required to cover the successive sections of the entire course, providing the airplane maintains a constant air-speed of 40 m.p.s.

Briefly, this table shows that, through the assistance given by the winds, the entire trip from Newfoundland to Ireland could be made in about 17 hours, whereas in still air about 21 hours would have been required. This period would have been fairly favorable also for the journey by way of the Azores, although less assistance would have been furnished by the winds than along the northern route. In general, "favorable" conditions for the eastward and westward trips along the two routes may be thus summarized:

(*a*) Newfoundland to Ireland: High pressure at latitudes 35 deg. and 45 deg. N. and low pressure at latitudes 55 deg. to 65 deg. N. with axes extending from west to east, so that isobars run nearly parallel to the latitude.

(*b*) Newfoundland to Portugal via the Azores: High pressure at latitudes 30 deg. to 40 deg. N., central near the Bermudas with crest extending eastward, and low pressure at latitude 50 deg. N., central about 1000 kilometers east of Newfoundland. Under this pressure distribution isobars extend east-southeastward from Newfoundland to the Azores, thence eastward to Portugal.

(*c*) Ireland to Newfoundland: Reverse the conditions given under (*a*).

(*d*) Portugal to Newfoundland via the Azores: Reverse the conditions given under (*b*).

In all cases, the greater the pressure gradient, the greater would be the wind assistance. Occasionally there is found a high-pressure area at about latitude 45 deg. N. with its axis extending from west to east. This condition would be favorable for both the eastward flight by the northern route and the westward flight by the southern route. An unfavorable day for any of the journeys would be one on which conditions are the reverse of those stated under (*a*), (*b*), (*c*), and (*d*), respectively. Another type of pressure distribution unfavorable for all the journeys and one which often occurs, especially during winter, is that in which low pressure extends as a troughlike depression from north to south across both routes. Under this condition winds almost at right angles to an airplane's course would be encountered and would materially reduce the resultant speed.

In order to determine, as nearly as possible, the average number of days on which favorable conditions might be expected for the four journeys during different months, all of the daily marine synoptic weather maps for the 10-year period, 1906 to 1915, inclusive, have been examined and classified. This classification has been made by Messrs. F. G.

TABLE III.—TIME REQUIRED FOR FLIGHT FROM NEWFOUNDLAND TO IRELAND UNDER CERTAIN SPECIFIED CONDITIONS OF PRESSURE DISTRIBUTION AND OF AIRPLANE SPEED AND CONTROL

Section	Bearing	Distances	Gradient winds		Airplane headed	Resultant speed	Time
			Bearing	Speed			
				m.p.s. (m.p.h.)		m.p.s. (m.p.h.)	
		Km. (miles)					Hrs.
1	E.22° N.	620 (385)	Variable	.. (..)	E.22° N.	40 (90)	4.3
2	E.17° N.	375 (235)	E.	8 (18)	E.20° N.	48 (107)	2.2
3	E.13° N.	355 (220)	E.12° S.	14 (31)	E.21° N.	52 (116)	1.9
4	E.9° N.	345 (215)	E.8° S.	16 (36)	E.16° N.	55 (123)	1.7
5	E.5° N.	340 (210)	E.9° S.	16 (36)	E.11° N.	55 (123)	1.7
6	E.2° N.	330 (205)	E.6° N.	16 (36)	E.	56 (125)	1.6
7	E.1° S.	330 (205)	E.18° N.	16 (36)	E.8° S.	55 (123)	1.7
8	E.5° S.	345 (215)	E.23° N.	14 (31)	E.14° S.	52 (116)	1.8
Total		3040 (1890)					16.9

Tingley and George Paterson of the marine section of the Weather Bureau and by the writer of this paper. Each one inspected about a third of all the maps for each month, after having first compared results on a number of maps inspected independently by all three. In this way it is believed that errors of personal judgment have been reduced to a minimum. The basis of classification is as follows: An excellent day is one on which assisting winds prevail at all points along the route so that the advantage in time is about three hours or more; a good day, one on which assisting winds predominate, although head or cross winds prevail part of the way, the assistance giving a gain in time of one to three hours; fair, one on which the proportion of favoring winds is slightly greater than that of head or cross winds, so that the time required for a flight is nearly the same as if there were no winds whatever; and poor, one on which head or cross winds predominate or one on which very stormy conditions prevail. The results of the classification appear in Table IV.

TABLE IV.—AVERAGE NUMBER OF DAYS, EXCELLENT (E.), GOOD (G.), FAIR (F.), AND POOR (P.) FOR TRANS-ATLANTIC FLIGHT.

	Newfoundland to Ireland				Newfoundland to Portugal				Ireland to Newfoundland				Portugal to Newfoundland			
	E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P
January	8	7	4	12	5	4	8	14	0	1	2	28	3	3	4	21
February	3	7	4	14	2	7	4	15	0	0	0	28	1	1	2	24
March	3	7	4	17	3	6	6	16	1	1	1	28	0	3	3	25
April	2	5	8	15	1	6	7	16	0	2	3	25	0	2	6	22
May	5	7	4	15	3	8	8	12	0	2	2	27	1	1	3	26
June	2	8	6	14	1	5	5	19	0	2	2	26	0	2	5	23
July	6	7	8	10	2	6	11	12	1	2	5	23	1	3	8	19
August	5	8	7	11	3	5	7	16	0	1	1	29	0	2	4	25
September	3	6	6	15	3	5	8	14	1	1	1	27	1	2	4	23
October	3	8	5	15	1	8	7	15	0	0	0	31	0	3	3	25
November	1	5	6	18	0	6	5	19	0	1	1	28	0	4	3	23
December	2	9	5	15	2	9	6	14	0	1	0	30	0	2	1	28
Annual	43	84	67	171	26	75	82	182	3	14	18	330	7	28	46	284

Dropping from further consideration the two classes designated fair and poor and combining the first two classes into one group as constituting all of the days that are favorable for trans-Atlantic flight, we obtain the results indicated in Table V.

TABLE V.—AVERAGE NUMBER OF DAYS, MONTHLY, SEASONAL AND ANNUAL, FAVORABLE FOR TRANS-ATLANTIC FLIGHT

	Newfoundland to Ireland	Newfoundland to Portugal	Ireland to Newfoundland	Portugal to Newfoundland
January	15	9	1	6
February	10	9	0	2
March	10	9	2	3
April	7	7	2	2
May	12	11	2	2
June	10	6	2	2
July	13	8	3	4
August	13	8	1	2
September	9	8	2	3
October	11	9	0	3
November	6	6	1	4
December	11	11	1	2
Spring	29	27	6	7
Summer	35	22	6	8
Autumn	27	23	3	10
Winter	36	29	2	10
Annual	127	101	17	35

From these two tables it is at once apparent, as was to be expected, that but little assistance from winds can be gained for the westward trip along either the northern or the southern course. For the eastward trip, however, such assistance may be expected approximately one-third of the time, the percentage of favorable days being slightly greater along the northern route, due to its lying entirely within the region of the prevailing westerlies.

The foregoing classification has been based on the assumption that the flying level is about 500 to 1000 meters above the surface. At greater altitudes, as already shown, the percentage frequency of westerly winds rapidly increases and, therefore, the percentage of favorable days for an eastward flight would become larger, probably increasing to 70 per cent or more at the 3-kilometer level. Conversely, the percentage of favorable days for a westward flight would decrease, although it is difficult to imagine a much smaller percentage than that indicated in Tables IV and V. Probably at the present time the most favorable height, all things considered, for trans-Atlantic flying is between 1 and 3 kilometers above the surface for the eastward trip and about 500 to 1000 meters for the westward trip.

It is recognized, of course, that there are other meteorological factors, besides wind conditions, that enter into the determination of the relative favorableness or unfavorableness of a day for flight, such, for example, as cloudiness, precipitation, etc. Except in so far as landing is concerned, however, wind is the one element of paramount (and, at the present time at least, most vital) importance. Cloudiness and precipitation do not extend to very great heights over the ocean, because the high relative humidity causes condensation at a lower level here than over the land. As a rule, therefore, an aviator would be able to fly above these conditions, particularly if they covered relatively small areas. On some days stormy conditions prevail over a considerable portion of the ocean, and such days, as already stated in the paragraph preceding Table IV, have been classed as unfavorable. In this connection it is interesting, and at first thought somewhat surprising, to find that the winter season shows up so well for eastward flight as compared with the other seasons, but it should be remembered that whenever conditions *are* favorable during that season, they are decidedly so, because of the greater strength of the prevailing westerlies at that time of year. Many days in summer, otherwise excellent, have only light and variable winds and have therefore been classified as fair. The transition seasons, spring and autumn, have, on the one hand, more stormy days than does summer and, on the other hand, more quiet days than does winter. Hence, the percentage of favorable days is less than during the two extreme seasons.

In this paper attention has been confined for the most part to the application of meteorological conditions over the Atlantic Ocean to flight with heavier-than-air machines. The statements made apply equally well to airships. These, however, by reason of their greater capacity for fuel, and owing, moreover, to the fact that they are not dependent on motive power to sustain them, are capable or remaining in the air a relatively long time and are therefore not so vitally dependent upon favorable wind conditions as are airplanes.

Conclusions

1. In the present stage of their development and until improvements give them a much larger cruising radius than they now have, airplanes can not safely be used for trans-Atlantic flight except under favorable conditions of wind and weather.

2. Observations of conditions over as great an area as possible, and particularly along and near any proposed course, should therefore be available at as frequent intervals as possible, these observations to include free-air as well as surface conditions.

3. With such observations at hand the meteorologist is able quickly to determine the current and probable future wind conditions along a proposed route and to advise an aviator as to the suitability of a day for a flight.

4. If a day is favorable, the meteorologist is able to indicate the successive directions toward which an airplane should be headed in order to keep to any desired course; also, to calculate the assistance that will be furnished by the winds.

5. Inspection of marine weather maps shows that at an altitude of 500 to 1000 meters conditions are favorable for an eastward trip approximately one-third of the time, the percentage being slightly greater along the northern than along the southern route. At greater altitudes the percentage of favorable days materially increases, especially along the northern route. For the westward trip the percentage of favorable days is so small as to make trans-Atlantic flight in this direction impracticable until the cruising radius of aircraft is increased to such an extent that they are relatively independent of wind conditions.

6. All things considered, conditions for an eastward flight are most favorable along the northern course; for a westward flight they are most favorable along the southern course; that is, the prevailing westerlies are less persistent along this course than farther north.

7. There seems to be little choice as to season, for although

the prevailing westerlies are stronger in winter than in summer, yet on the other hand, stormy conditions are more prevalent in winter, and the net result is about an equal percentage of favorable days in the two seasons. Moreover, the greater fog percentage in summer just about offsets the greater percentage of cloudiness in winter. Fog is a disadvantage chiefly because of its interference in making observations with drift indicators. The Newfoundland fogs in general are of small vertical extent and do not extend far inland. They should not, therefore, prove a hindrance to landing, if the landing field is located some distance from the coast.

8. Most important of all, there is need for a comprehensive campaign of meteorological and aerological observations over the North Atlantic in order that aviators may be given data for whose accuracy the meteorologist need not hesitate to vouch, instead of information based on so small a number of observations, particularly of free air conditions, that the deductions, including some of those in this paper, are assumed and not proved, are given with caution, and are "subject to change without notice."

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Book Review

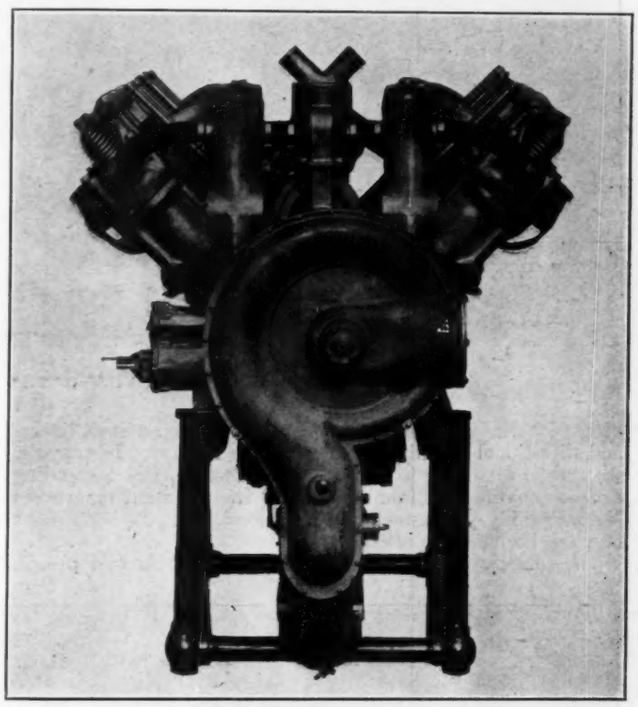
AEROBATICS. By H. Barber, A. F., Ae.S. (Robert McBride & Co., New York. 61 pp. 29 ill.)

Captain Barber's latest book is sound and extremely interesting. A flying instructor of many years experience, he has in this small book written exactly what the flying student ought to know, in a simple and picturesque manner. Part 1 deals with Elementary Flying, Part 2 with Aerobatics, a name Captain Barber invents for stunt flying. The illustrations are wonderfully good and help to render the most complicated maneuver understandable. The book is useful not only to the flying student, but the designer, who, unless he is an experienced flyer himself, does not always visualize flying operations any too successfully.

Sturtevant Supercharging Device

The weight of the B. F. Sturtevant Company's supercharging device as at present constructed is 50 lb., although this weight will be reduced in later construction. The fan wheel itself revolves at ten times the speed of the engine crankshaft, at normally 22,500 r.p.m. At this speed a pressure of approximately two atmospheres maximum is obtained. The pressure of course can be varied by varying the relative speed of the fan.

The compressor is driven by an external belt at the ratio of 2:1 to the crankshaft, while inside the housing adjacent to the fan is a pair of herringbone gears giving a reduction of 5:1. The gears run in oil and the bearings upon which both the gear-



shaft and the fanshaft revolve are oiled from the pressure system of the engine. The oil is finally led back to the engine sump by gravity.

The speed of the fan is variable and controlled by means of an aneroid so that the outlet pressure is always that obtaining at sea level. Of course if the plane ascends above that point at which the blower is designed to operate, the pressure will begin to fall and the engine will be operating much the same as when leaving the ground without the connection of the supercharging device. In addition to the automatic control, a manual control is provided so that the pilot can cut out the supercharging device or throw it in at will.

A point which is important to consider in connection with the arrangement of the device is the fact that all the apparatus is added to the engine and yet in no way influences its operation mechanically. Only a comparatively small amount of power is taken from the end of the crankshaft and if, for any reason, it is desirable to cut out the supercharging fan in the air, the engine will operate exactly as well as though it were normally equipped. What more, with the latest Sturtevant design, all that is required for applying this supercharger to any engine is to provide a coupling on the end of the crankshaft and an air connection to the carburetor.

Aeronautical Patents

ISSUED MARCH 11, 1919

1,296,848—To Richard Fitz Power, Doveridge, England, assignor of one-half to Oliver Wolcott Thomas, Ithaca, N. Y. Control of aeroplanes.

1,297,032—To Frank S. Stirton, Springfield, Ontario, Can. Aeroplane

1,296,667—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Wing-post socket.

The Lepère Two-Seater Fighter

One of the most successful planes developed during the war is the Lepère two-seater fighter, designed and built by Capt. Georges Lepère, with a group of French associate engineers, at the plant of the Packard Motor Car Co., Detroit.

It belongs to the class of two-seater fighters of the DeH-4 and Bristol type, and would seem to mark progress over both these makes.

Flying Qualities—The machine exhibits excellent flying qualities, with ready response of all controls. Longitudinal, lateral and directional stability of the machine is good. In taxying, starting and landing it is entirely satisfactory, and on landing it does not roll more than 300 or 400 ft. All stunt maneuvers can be readily performed, and in general, from a pilot's point of view, the machine is excellent.

The range of vision is very good, the controls well placed, and instruments so arranged that the pilot need only move his eyes.

Wing Truss—The wing truss offers a number of interesting peculiarities. In addition to the usual lift and landing wires, two wires are carried forward to the chassis struts, where these support the fuselage from the upper and rear spars at the inner strut points, these wires serving partly as lift wires and partly as external drift wires. From the lower strut points wires are carried to the chassis, where a stout strap is carried across. This trussing is very strong, because lift wires carried to the chassis certainly carry some of the lift load; but whether it is worth while to achieve this at the expense of so much greater head resistance is a doubtful point.

Another striking peculiarity of this design is the fact that there are no incidence or stagger wires in the plane, these being replaced by a system of portal framed struts as shown in Figs. 2 and 3. These are built up of layers of spruce. Measurements of stress in incidence wires during sand test would seem to indicate that the initial tension in them is rather relieved than otherwise by flight loads, and portal frames of this character are amply strong. They have the disadvantage of extra weight, but cut down resistance and have the advantage of simplicity.

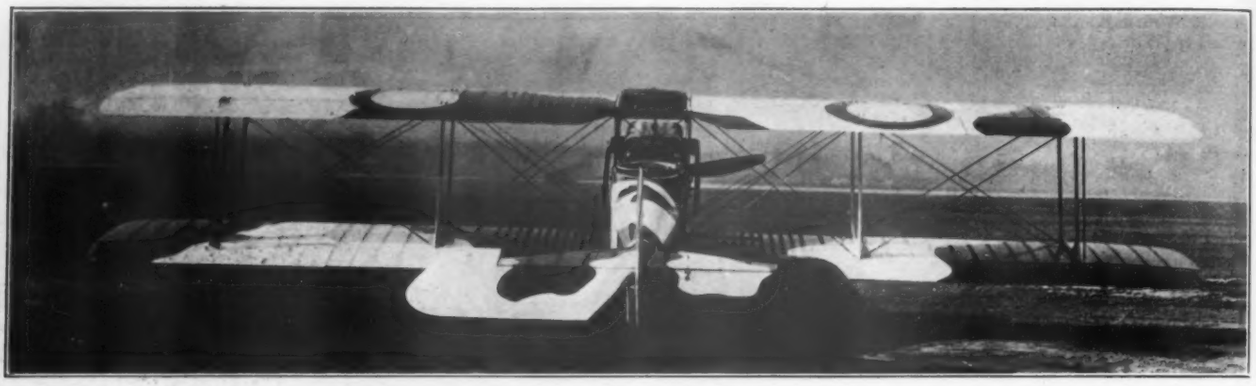


FIG. 1. REAR VIEW OF THE LEPÈRE TWO-SEATER FIGHTER

The fuselage wing struts are of a type similar to the outer struts, but go right down through the fuselage and rest on the heavy beams which connect through the spars of the lower wing. These struts may be seen in Fig. 6.

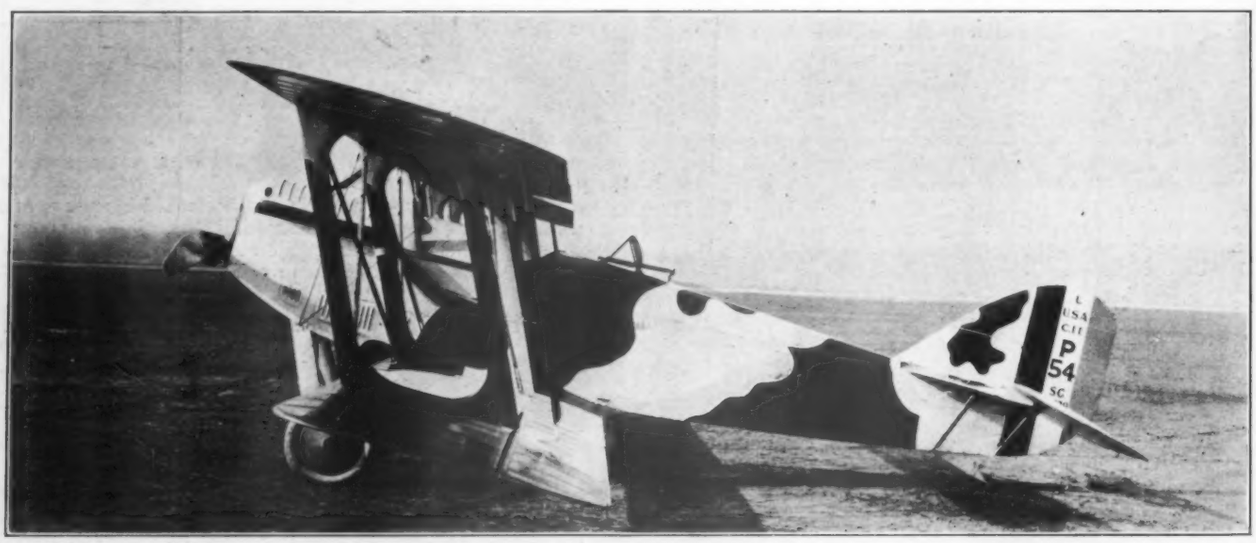


FIG. 2. SIDE VIEW OF THE LEPÈRE TWO-SEATER FIGHTER

The spars are of the usual spruce routed I-section type, and the trailing edges are aluminum strips 1 in. x $\frac{1}{8}$ in., to which the ribs are tacked.

The ribs are strongly reinforced by tightly fitting spruce stiffeners glued to the webs at five points. A piece of doped tape wrapped around the rib at each stiffener holds the flanges in close contact with the ends of the stiffeners. Three-ply veneer strips cover the upper surface of each wing from the front spar to the leading edge, adding stiffness in the plane of the drift trusses and taking up slip stream and high suction effects on the wing.

The fittings throughout are rather heavy, but have some desirable features. Fig. 4 is a sketch of one of the spar fittings taking lift, drift and landing wire members. The main part of the fitting is built up of two plates of 5/64 in. gage riveted and sweated together and fastened to the spar by two $\frac{5}{16}$ in. bolts passing horizontally through the spar at its neutral axis. The clip for the internal drift wires is held on by the same two bolts. The framed interplane struts are held rigidly at each corner to the spars by four ¼ in. bolts passing through plates on the upper surface of the wing, as shown in Fig. 4.

The weight per square foot of the entire truss is 1.4 lb., which is somewhat heavier than the average for a plane of this type. But the factor of safety on sand test was very high, attaining a value of 8.5.

Aileron Control—The aileron control is of the rigid type, very much liked by French constructors and increasing in

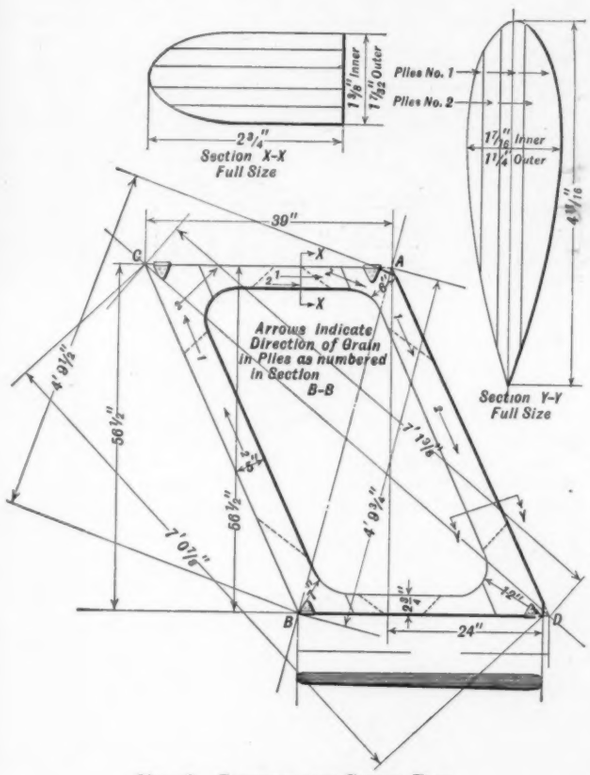


FIG. 3. INTERPLANE STRUT BAY

favor in England and this country. A somewhat heavy push rod is carried through the wings, and with a simple bell crank lever connection is made to the aileron arm (Fig. 5) on the lower aileron. Another aileron arm is placed on the upper surface of this aileron and connects to the upper aileron by a small steel strut screwed into a part of the aileron arm. The control is very rigid and positive.

Tail Surfaces—The general arrangement of the tail surfaces may be gathered from Figs. 1 and 2. The stabilizer is supported by two steel rods on either side and fits snugly on the veneer covered fuselage. The elevator is of very simple construction. The ribs are all spruce, with no cut-outs in the web. The main spar is built up of spruce and 3-ply mahogany, while the secondary spar is a spruce rod. A ⅝ in. strip of aluminum forms the trailing edge, with ash bent to shape for the curved portion at the tips. The masts are in two parts, welded together and held to the main spar by four bolts, a very simple and effective attachment. The stabilizer and rudder are of very similar construction; the fin has no spar, but is covered with thin 3-ply.

The actual controls call for no special notice. In sand testing, the horizontal control system failed at 20 lb.-sq. ft., and the rudder mast crushed at 30 lb.-sq. ft. With slight subsequent alterations, both systems were ultimately satisfactory.

The Fuselage—The fuselage is of exceedingly strong but somewhat heavy construction. It is covered in by side panels of 6-ply veneer, running from end to end, of a total thickness of 5/32 in., and composed of 2-ply ¼ in. mahogany, 3-ply 1/32 in. mahogany and 1-ply 1/32 in. white wood. At the engine end of the fuselage, the side veneer panels are cut down so as to follow the longeron system, and big cut-outs provide plenty of ventilation for engine and radiator. The lower panel

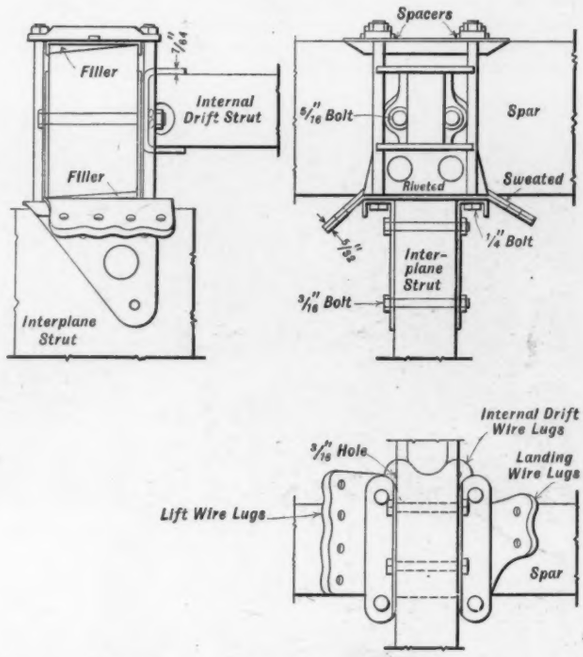


FIG. 4. FITTINGS AT RIGHT, UPPER, FRONT, INTERMEDIATE STRUT BASES

is of 3-ply, 3/32 in. total thickness, built up of 2-ply 1/32 in. mahogany and 1-ply 1/32 in. white wood. As well as being attached to the longerons, the side and bottom panels are laced together. Transverse panels are placed at intervals along the fuselage, six in all, including a small bulkhead at the center of the engine bed. A system of diagonal bracing is also carried

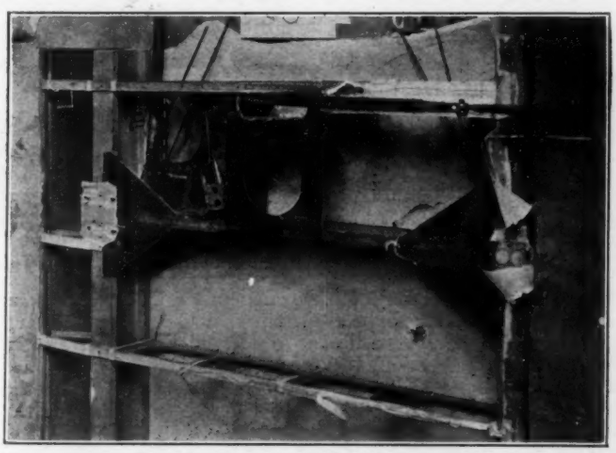


FIG. 5. AILERON CONTROL

along the fuselage, the diagonal braces consisting of routed spruce struts solidly glued and butting into the longerons.

Engine Mounting—At the front fuselage wing struts, the upper longeron is cut away to allow room for the wing struts. Two short spruce longerons then continue to the front end of the engine mounting. This introduces an element of weakness, counteracted, however, by a wire brace carried from the front end of the engine bearers to the top of the fuselage wing struts. The engine bearers are of spruce with a top of ash-spruce

laminations, and rest on the two transverse bulkheads. In the veneer sides of the engine section are sliding vent holes, which give good accessibility. The general arrangement of the engine mounting is clearly illustrated in Fig. 6.

Landing Gear—This is of extremely solid construction and provides support for the inner wing struts, which go straight down through the fuselage to the lower longerons, and also for the engine mounting. The use of a 3-strut landing gear providing such support would seem perfectly justified for a machine of this type. The three struts are of laminated spruce construction, with interlocking laminations of grains running

FIG. 6. FRONT PART OF THE FUSELAGE, SHOWING BULKHEADS, ENGINE BEARERS AND CABANE BAYS

in the appropriate direction, forming one solid homogeneous structure. An oval-shaped opening provides the necessary guide for the axle. The design of the shock-absorber system is neat and well stream-lined. Two compression tubes are freely hinged at either end, and are stream-lined in with the axle of the plane. The support of the cross tube carrying the rubber cord might, perhaps, be simplified. A number of steel plates pass round and fasten to the lower part of the strut structure and themselves carry the cross tube.

Power Plant—The installation of the Liberty-12 in the Lepère is interesting in that it differs in some respects from that found in the DH-4 and USD-9A.

The power plant has been made more accessible, first, by mounting the radiator in the center section of the top wing, and, second, by mounting the carbureters at the sides of the engine toward the rear. This has been accomplished by designing long intake manifolds.

The installation in general is very satisfactory. The extraordinary accessibility of the two Zenith Duplex Compensating Carbureters is a noteworthy feature of this installation. The fire hazard is also reduced by this arrangement as against the customary one of locating the carbureters in the alley.

Cooling System—The cooling system of the Lepère two-seater, shown in Fig. 7, differs from that used on most Ameri-

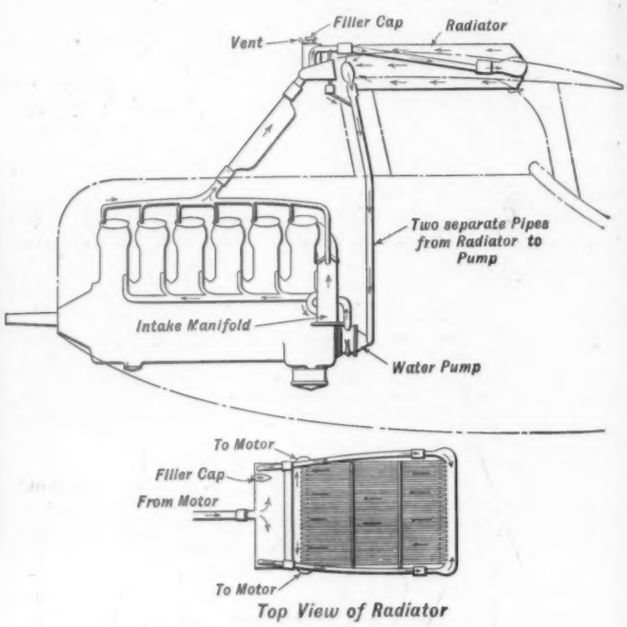


FIG. 7. WATER CIRCULATION SYSTEM

can planes in that the radiator is mounted overhead in the center section of the upper plane. This location has certain advantages. It decreases the resistance to the forward motion of the plane and gives the pilot better vision. In fact, the excellent vision of the Lepère is commented on by pilots who have flown this ship. This location is also favorable because of its height above the engine.

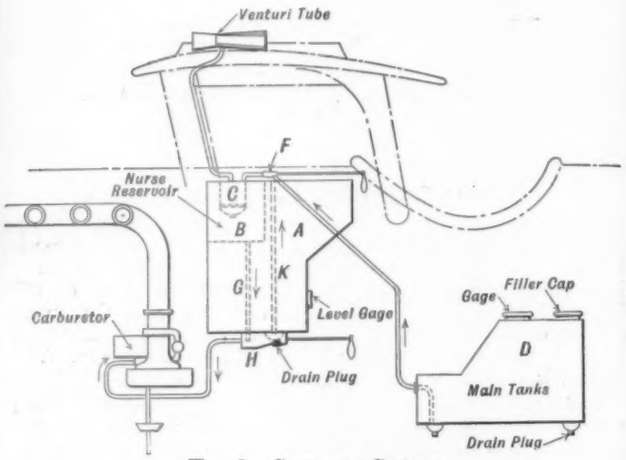


FIG. 8. GASOLINE SYSTEM

The radiator is attached to the wings by means of suitable clips riveted to radiator and bent to hook over the wing spars.

This location of the radiator hinders the lifting power of the upper plane a little, but is more than offset by the decrease in resistance offered by considerable frontal area, as is the case with the DH-4 and USD-9A.

There is perhaps one disadvantage worth mentioning with the radiator mounted overhead. Should the radiator become punctured in some way, the pilot and observer are liable to get scalded.

In regard to accessibility, this location is more favorable than with a front mounting. With the radiator mounted in front, it is necessary to remove the propeller, whereas overhead it is obvious that this would not be necessary.

The following data is available on the Lepère radiator:

Radiating surface, 35,520 sq. in.
Length, 31 in.
Width, 27 in.
Core, 7 in.
Frontal area, 783 sq. in.
Water capacity, 41.6 lb.
Water flow, 80 gal. per min.
Head, 18 in.
Free water area, 61.62 sq. in.
Depth, 25.5 in.
Free air area, 124.68 sq. ft.
Weight, 127 lb.

Gasoline System—The gasoline system is shown diagrammatically in Fig. 8. The gasoline is carried in three main tanks; two lower ones, *D*, and one upper tank, *A*. Inside of tank *A* and integral with it is a separate reservoir, *B*. The operation of the system is as follows:

A Venturi tube is suitably located above the lower wing and is connected by a pipe to the vacuum chamber *C*. The vacuum created in this chamber causes gasoline to flow from tank *D* through pipe *E* to the two-way valve *F*. From this valve the gas flows to the vacuum chamber *C*, from which it is dumped into the nurse reservoir *B*. From this reservoir, *B*, gasoline flows by gravity through pipe *G* and two-way valve *H* to pipe *J*, thence to carbureter. When tanks *D* are empty, valve *F* is turned to its other position and gasoline is then drawn from tank *A* through line *K*. After reaching valve *F* the gasoline flows through the same channels as in first case.

If the vacuum chamber should become inoperative, it is possible to fly by drawing gasoline direct from tank *A* without passing through the nurse reservoir *B*. This is accomplished by turning valve *H* to another position, when it will draw gasoline directly from the sump at the bottom of tank *A* by gravity, and thence through pipe *J* to the carbureter.

Main Dimensions

Span, 41 ft. 7¼ in.
Total length, 25 ft. 3½ in.
Total height, 9 ft. 7 in. (standing on ground).
Height at hub of propeller above ground, in flying position, 5 ft. 3¾ in.
At rest, 6 ft. 3 in.
Stagger, 24 11/16 in.
Dihedral, none.
Sweepback, none.
Decalage, none.
Gap, 60⅝ in.
Upper wing: area, including ailerons, 206.8 sq. ft. Span, 41 ft. 7¼ in. Chord 65¾ in.
Lower wing: area, including ailerons, 208.6 sq. ft. Span, 41 ft. 7¼ in. Chord, 65¾ in.
Incidence for both planes, 1 deg.

Control Surfaces

Stabilizer area, 17 sq. ft.
Elevator area, 33.4 sq. ft.
Vertical fin, 3.4 sq. ft.
Rudder area, 13.1 sq. ft.
Ailerons: 32.2 sq. ft. in upper wing; 32.2 sq. ft. in lower wing.

Fuselage

Maximum cross-section rectangular in shape.
Maximum cross-section, 2 ft. 10 in. x 4 ft. 0 in. deep.

Landing Gear

Number of wheels, 2.
Tread, 65⅛ in.
3 strut type.

Power Plant

Liberty-Packard, 12-cyl.
Horsepower at 1700 r.p.m., 400.
Weight dry, 825 lb.
Delco ignition and volt generator.
Willard battery, 4 cell, 8 volt.
Advance, 30 deg.
In flying, generator and distributor used.
2 Zenith Duplex compensating carburetors.
Propeller, 2-bladed, 9 ft. 10 in. diameter, 7 ft. 3 in. pitch.

Oil Tanks

One tank under motor, between bulkheads.
Capacity, 45 lb. Oil pressure, minimum, 20 lb.; oil pressure, maximum, 40 lb. Maximum temperature, 150 deg.

Gasoline Tanks

Number, 3.
Reserve tanks under cowl, 2 main tanks under pilot's seat.
Capacity of main tank, 210.5 lb.
Capacity of reserve tank, 219.5 lb.
Main feed system, vacuum.
Reserve feed system, vacuum.

Armament and Equipment

Two Marlin guns right hand side of fuselage	48 lb.
"CC" synchronizer	25 "
Ammunition, 1000 rounds	66 "
Aldis sight	3 "
Two Lewis guns (with yoke and sights)	41 "
One scarf mount	26 "
Ammunition, 970 rounds	79 "
One fire extinguisher	5 "
Oxygen equipment	26 "
Instruments	22 "
Total weight of armament and equipment	341 lb.

Weight Distribution

Structural weight empty (including instrument board)		2465.9 lb.
Water in engine radiator and piping		85.6 "
Total weight, empty		2551.5 lb
Fuel and Oil		
Fuel, 73½ gal	437 lb.	
Oil, 5½ gal	46.5	
Total	483.5	
Useful Load		
Pilot, observer and clothing	360 lb.	
Armament and equipment	341 "	
Total useful load	701 lb.	
Total		3746.0 lb.

Power loading, 9.35 lb./hp.
Wing loading, 9.05 lb./sq. ft.

Summary of Test Results

Altitude	*Time*	*R.P.M. Climbing*	*Speed Level*	*R.P.M. Level*
5,000	4.4 min.	1520	130.4	1700
10,000	9.8 "	1545	127.6	1685
15,000	17.5 "	1530	122.4	1640
18,000	25.7 "	1490	110.0	1580
20,000	36.6 "	1445	94.0	1495

Service ceiling, 20,200 ft.

Air Mail Service

MONTHLY REPORT OF OPERATION AND MAINTENANCE, MARCH, 1919

Airplane No.	Gas	Grease and Oil	Office Force	Motor Cycles Trucks	Rent, Light, Fuel Power Telephone Water	Misc.	Pilots	Mechanics and Helpers	Repairs and Accessories	Interest on Investment	Departmental Overh'd Charge	Total	Service and Unit Cost: Gal. of Gas	Total time hr.	Total time min.	Total miles run	Miles run per gal. gas	Cost per hr.	Cost per Mile
2	$25.07	$1.92	$29.42	$60.81	$28.32	$111.38	$42.60	$48.13	$40.45	$58.46	$59.48	$506.04	82	3	37	248	3.02	$139.80	$2.04
3	89.69	23.23	62.37	60.81	40.33	122.92	153.53	280.29	23.60	58.46	59.48	974.71	294	13	02	872	2.97	75.00	1.12
4	15.10	.55	43.37	60.81	19.48	55.77	11.76	31.72	49.00	58.46	59.48	405.52	50	1	00	90	1.80	405.52	4.51
7	68.58	16.98	62.37	60.81	40.33	122.92	108.77	300.86	17.50	58.46	59.48	917.06	225	9	14	704	3.13	99.00	1.30
8	55.18	6.89	62.37	60.81	40.33	122.92	117.21	294.84	39.15	48.46	59.48	917.64	181	9	57	606	3.35	92.40	1.51
10	6.10	.....	32.95	60.81	12.01	44.77	.....	.....	49.10	58.46	59.48	323.68	20	..	..	....	....	....	....
11	109.08	24.93	62.37	60.81	41.33	122.92	242.36	297.24	129.90	58.46	59.48	1,208.88	359	20	44	1,486	4.14	58.20	.81
12	37.22	4.28	29.42	60.81	28.32	111.38	133.51	98.39	36.75	58.46	59.48	658.02	122	11	20	722	5.92	58.20	.91
14	118.97	27.93	62.37	60.81	40.33	122.92	291.94	283.31	190.20	58.47	59.48	1,316.73	392	24	47	1,900	4.85	53.40	.69
15	157.24	32.42	62.37	60.80	39.73	122.92	375.19	303.13	71.58	58.46	59.47	1,343.31	517	31	51	2,387	4.62	42.00	.56
30	124.97	11.15	43.37	60.80	19.48	55.77	36.71	243.78	67.00	58.46	59.47	780.96	414	3	07	180	.43	250.80	4.34
38	40.18	10.30	43.37	60.80	19.48	55.77	31.81	243.78	186.45	58.46	59.47	809.87	133	2	32	218	1.64	319.80	3.71
39	92.54	17.69	62.37	60.80	40.33	122.92	97.19	262.87	24.12	58.46	59.47	898.76	304	8	15	652	2.14	109.20	1.38
43	124.56	19.80	62.37	60.80	40.33	122.92	86.98	245.14	88.40	58.46	59.47	969.23	408	7	23	433	1.05	131.40	2.24
24224	18.15	5.70	10.42	60.80	7.47	44.23	9.75	31.72	12.00	58.46	59.47	318.17	60	0	50	90	1.50	381.60	3.54
38275	33.49	4.33	29.42	60.80	28.32	107.38	20.62	33.39	272.85	58.46	59.47	708.53	111	1	45	128	1.15	405.00	5.54
39364	.....	.....	19.00	60.80	20.85	96.38	.....	46.57	5.82	58.46	59.47	367.35	....	..	..	....	....	....	....
39365	50.94	1.41	19.00	60.80	20.85	96.38	40.05	45.57	2.90	58.46	59.47	455.83	168	3	24	120	.71	133.80	3.80
Total	$1,167.06	$209.51	$798.70	$1,094.49	$527.62	$1,762.57	$1,800.00	$3,090.73	$1,306.77	$1,052.29	$1,070.55	$13,880.29	3,840	152	48	10,835	2.82	$90.80	$1.28

Cost per mile, overhead, $.42; cost per mile, flying, $.29; cost per mile, maintenance, $.57.
Note. This report includes the cost of complete overhauling of one JN-4-H and one R4-L, and rebuilding of one R4-L.

Course in Aerodynamics and Airplane Design

Part III.—Experimental Aeronautical Engineering

By Alexander Klemin

Technical Editor, Aviation and Aeronautical Engineering; Consulting Engineer, Aerial Mail Service; Consulting Aeronautical Engineer

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Section 4. Chassis Testing

Chassis testing is in many respects on a most unsatisfactory basis. The magnitude of the forces coming into play depends entirely on the type of landing made. If the pilot flattens out, flies at a distance of a foot or so above the ground, slackens his speed below stalling speed ever so slightly, and makes a gentle three-point landing, he may impose on the chassis a dynamic loading not exceeding 1½ times the weight of the machine. If he lands head-on, straight from the glide, he may impose the most severe shock, which the chassis can barely stand.

FIG. 1. GENERAL ARRANGEMENT FOR CHASSIS TESTING

There is also this difficulty, that whereas a three-point landing for a typical chassis such as the DeH-4 (illustrated later in this section) will throw the greater part of the load on the forward strut, a landing with the propeller axis horizontal will divide the load more evenly between the front and rear struts, while a landing head-on, or the meeting of a bump while taxying on the ground, will throw the load mainly on the rear struts.

Hence the generally adopted chassis strength factor of 6 or 7, and the testing of chassis to reproduce that division of load between front and rear struts which represents a landing with propeller axis horizontal is purely conventional, and, although providing a simple method of comparison, will by no means be fair to every type of landing gear. This type of loading is indeed a fair compromise, since it will, as a rule, divide loads between front and rear struts.

There also arises the question of side-swipe or side-landing. In this the chassis has to stand a large transverse component. To test a chassis under conditions simulating this, it is necessary to test on a laterally inclined platform, with a support placed against the wheel on the lower portion of the incline. The inclination, in the few cases of test hitherto conducted, has been such as to give a transverse load of one-third the vertical load, but the method is by no means fully developed.

Practical Methods of Testing Chassis. In Fig. 1 is shown a typical set-up of a chassis for test. A strong, well-braced jig is hinged to the wall of the building in which the test is being conducted. It carries at its end a box-like structure in which the pig lead can be piled. The chassis is set up underneath in

such fashion that it corresponds to the propeller-horizontal attitude of the machine. Rough planking is used, as shown in the photograph, to get the correct position for the chassis. The wheels are placed on heavy I-beams, whose ends rest on scale balances, so that the tendency for unequal loads to occur on

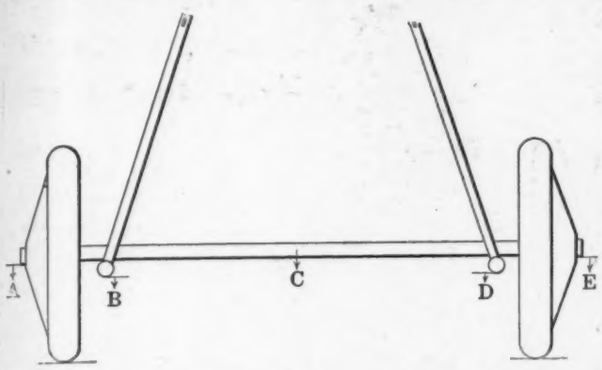


FIG. 2. POINTS AT WHICH DEFLECTIONS ARE MEASURED ON CHASSIS

the two wheels may be eliminated. Jacks are placed at the front end of the jig, to support it, while load is being piled on.

In measuring deflections a long lever-like arrangement has to be employed, so that it is not necessary for the observer to

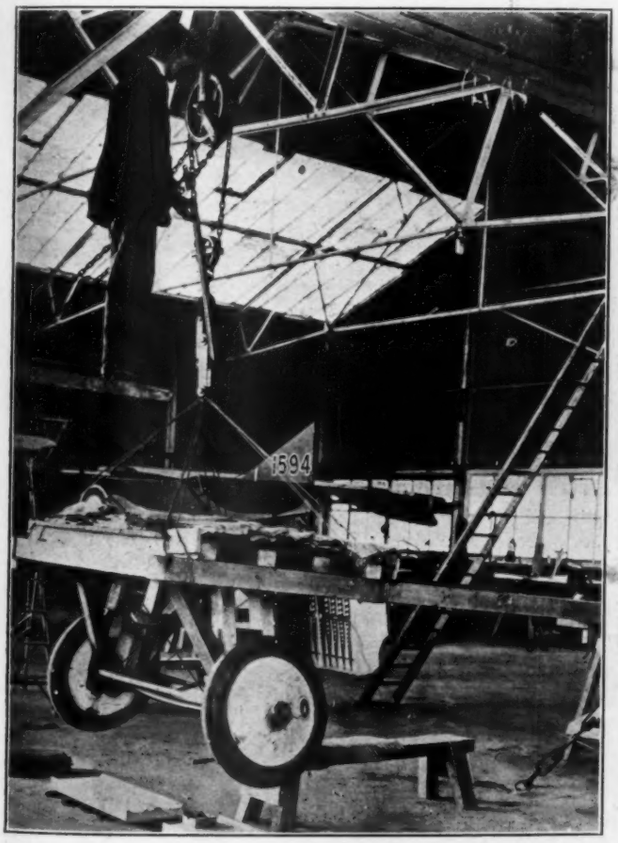


FIG. 3. IMPACT METHOD OF TESTING CHASSIS

get underneath the chassis. The points at which deflections are measured are shown in Fig. 2. Measurements at all these points are necessary, and in no other way can the net movement of the axle relative to the struts, and the true deflection of the center of the axle relative to its ends, be obtained. Loads are generally applied in increments of about 500 lb. In Table I are given the deflections measured for an SE-5 chassis (termed chassis E later in this section), which is that of a single-seater scout having a gross load 2050 lb.), and also in Table II the net deflections of the axle with respect to struts, and deflections of axle center relative to ends.

In English practice it is customary to adopt a different

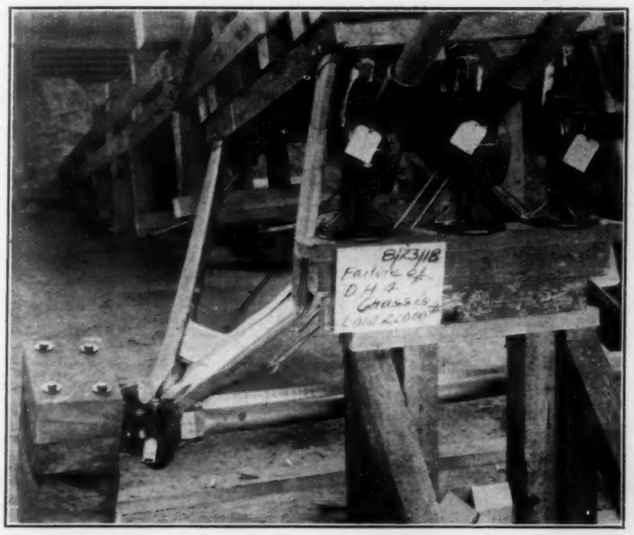


FIG. 4. FAILURE OF CHASSIS A

method of testing. The chassis is connected to a platform, as shown in Fig. 3, which is hinged at one end and is loaded with shot bags. It is allowed to drop from a definite height a num-

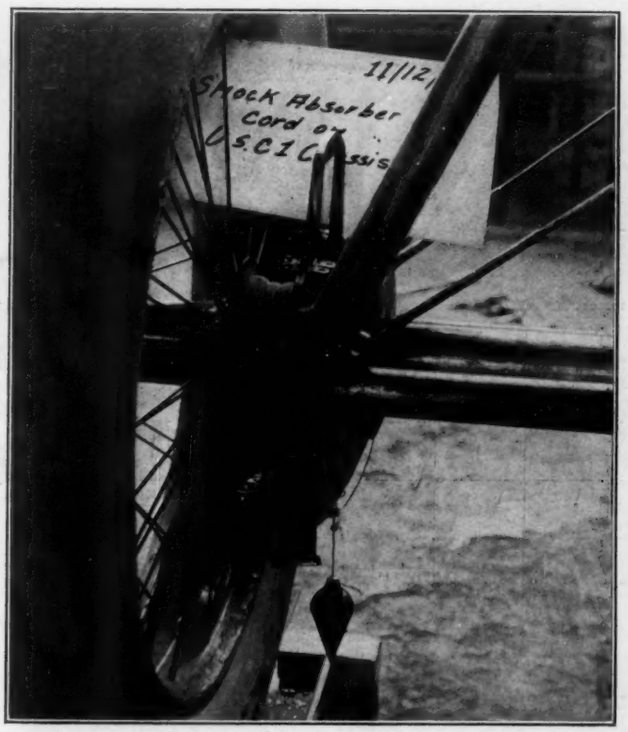


FIG. 5. CHASSIS B BEFORE TEST

ber of times, the force of the blow being increased at each test. This method has the advantage of simulating more closely the conditions of a blow, but precludes all deflection measurements, and also does not permit the exact failing load to be found so accurately.

Results of Tests. In Table III are given results of tests for chassis of some typical machines.

TABLE I

Load on Rt. Wheel (lb.)	Load on Lt. Wheel (lb.)	Deflection measured at A	B	C	D	E	Remarks
0	0	0	0	0	0	0	
475	525	1/16	1 1/16	1/16	1/16	3/16	
735	755	1/8	1 1/16	3/16	1/16	1/16	
955	950	1/16	1 3/16	1 1/16	1 1/16	1/16	
1235	1195	1/4	2 1/4	1 1/16	1 1/16	1/16	
1435	1375	3/16	2 1/16	1 1/16	1 3/4	3/16	
1672	1575	1 1/16	2 1/16	1 5/8	1 1/16	1	Right tire air pressure=75 lb. Left tire air pressure=77 lb.
1865	1780	3/16	2 3/8	1 1/16	2 1/4	1/16	
2115	2065	1	2 1/16	1 1/16	2 1/2	1 1/8	
2262	2395	1/16	2 5/8	2 1/16	2 5/8	1 1/4	
2495	2605	1 1/16	2 7/8	2 1/16	2 1/16	1 3/8	
2697	2785	1 1/8	3 1/16	2 1/2	3	1 1/16	Both tires pumped to 80 lb.
3045	3045	1 1/4	3 1/2	2 3/4	3 1/16	1 1/2	
3225	3230	1 1/4	3 5/8	2 1/16	3 3/8	1 1/16	
3465	3405	1 3/8	3 1/16	3 1/16	3 1/16	1 3/4	Tires compressed with this Load—pressure=85 lb.

Failure occurred when 250 lb. were added to each wheel

TABLE II

Deflection of axle with respect to right strut	Deflection of axle at center	Deflection of axle with respect to left strut
0	0	0
1/16	3/16	1/16
1/16	1/4	1/4
1 1/16	1/16	3/16
1 1/16	1/16	3/8
1 1/16	1/16	1/16
1 1/16	1/16	1/16
1 1/16	1/16	1/16
1 1/16	1/16	1
1 1/16	1/16	1 1/16
1 1/16	1/16	1 1/16
1 1/16	1 1/16	1 1/16
1 1/16	1 1/16	1 1/16
1 1/16	1 1/16	1 1/16
1 1/16	1 1/16	1 1/16
1 1/16	1 1/16	1 1/16
1 1/16	2	1 1/16

TABLE III

Machine	Type	Gross Load (lb.)	Weight of Chassis (lb.)	Load on Chassis at Final Failure (after reinforcement) and Factor of Safety.	Nature of Failure
(A) DeH 4	Two seater Fighter	3480	132	20,720 lb. 5.95	Front Struts Buckled
(B) USC 1	Two seater Combat	4000	135	10,500 lb. 2.62	Failure of guide plate due to eccentric loading.
(C)	Two seater Combat	2800	87	16,000 5.00	Front Struts Buckled
(D)	Single Seater advanced Training	1200	70	4,650 lb. 3.9	Tubing connecting steel struts at Bottom.
(E) SE5	Single Seater Pursuit Airplane	2050	97	7,370 lb. 3.56	Failure at point where rear strut is brazed to horizontal tubing.

In Figs. 4, 5, 6, 7, 8 and 9 are shown the failures for the five machines A, B, C, D and E, and these failures will be discussed in detail as an instructive piece of work in chassis design.

Chassis A is that of the well-known DeH-4, with front strut of spruce and rear struts of yellow poplar. The shock-absorber consisted of four units of eight loops each of 5/16 in. elastic cord. Under a load of 13,690 lb., the cords extended so far that the axle forced out the block which was mortised between the struts to form the top of the axle guide; the wheels

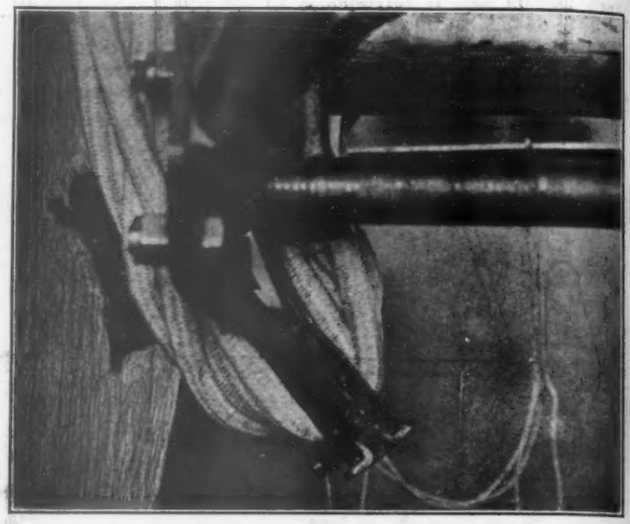


FIG. 6. CHASSIS B AFTER FAILURE

also failed by flattening of the rims, and a good many of the rubber strands parted. After the wheels had been removed and the cord replaced by flexible cable, the loading was continued up to 20,720 lb., at which point the front strut buckled. Here was a very interesting point in design. The strength of

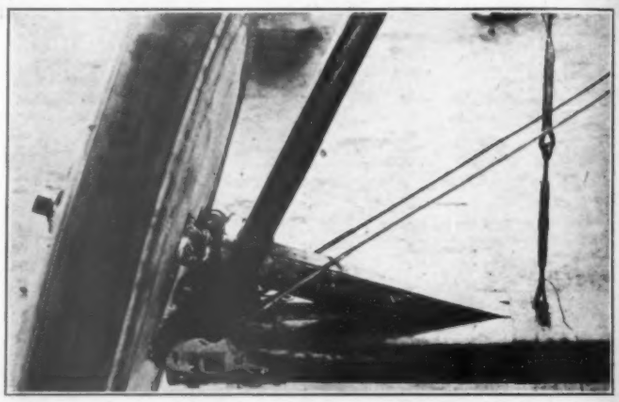


FIG. 7. FAILURE OF CHASSIS C

the main members is perfectly satisfactory, but the design is vitiated by the fact that there was not enough stiffness in the shock absorber, and the 750 x 125 mm. tires were not large enough for the load.

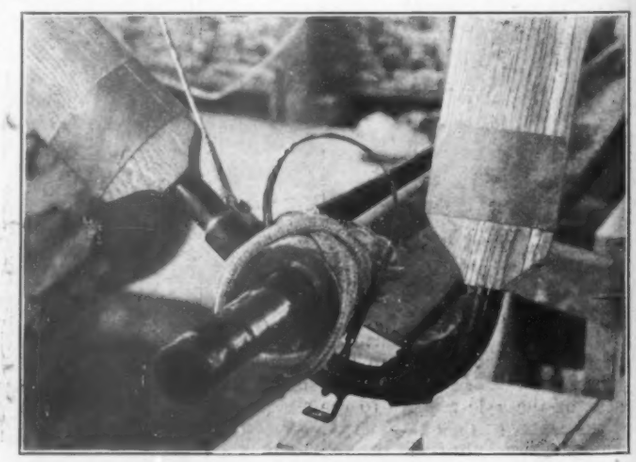


FIG. 8. FAILURE OF CHASSIS D

Chassis B gave an unsatisfactory result because of the eccentric forces unfortunately present in every design, which, acting through the cord, bent the slender guide plate. It is such features of the design that seem to require special care and escape the designer's attention.

In chassis C, after reinforcement, failure in the struts occurred at 15,370 lb., a perfectly satisfactory figure, but at as

FIG. 9. FAILURE OF CHASSIS E

low a figure as 9030 lb. the axle bridge supporting the cords gave away. Again a case where a minor member caused a disappointing failure.

Chassis D, with a factor of safety of 3.9, was just satisfactory. The photograph indicates that whereas the main members were amply strong, the designer had not sufficiently strengthened the lower cross-piece, where considerable bending moment is introduced by the strut cantilever action.

A similar failure occurred in the SE-5 (Chassis D), where a brazed cross-piece gave early trouble.

Army Aircraft to Fight Forest Fire

Army airplanes and captive balloons will cover portions of the National Forests of California, Arizona, New Mexico and other states this summer, to aid in detecting and suppressing forest fires. In compliance with an order from Secretary Baker directing the Air Service to co-operate with the Forest Service of the United States Department of Agriculture in this work, conferences are under way to determine where, and to what extent the air scouts will supplement the forest rangers.

That there is a distinct and important place for aircraft in fire protection of timberlands is regarded by the forestry officials as beyond doubt; this was constructively expressed by Henry S. Graves, Chief of the United States Forestry Service, in an article printed in the Jan. 15, 1919, issue of AVIATION AND AERONAUTICAL ENGINEERING.

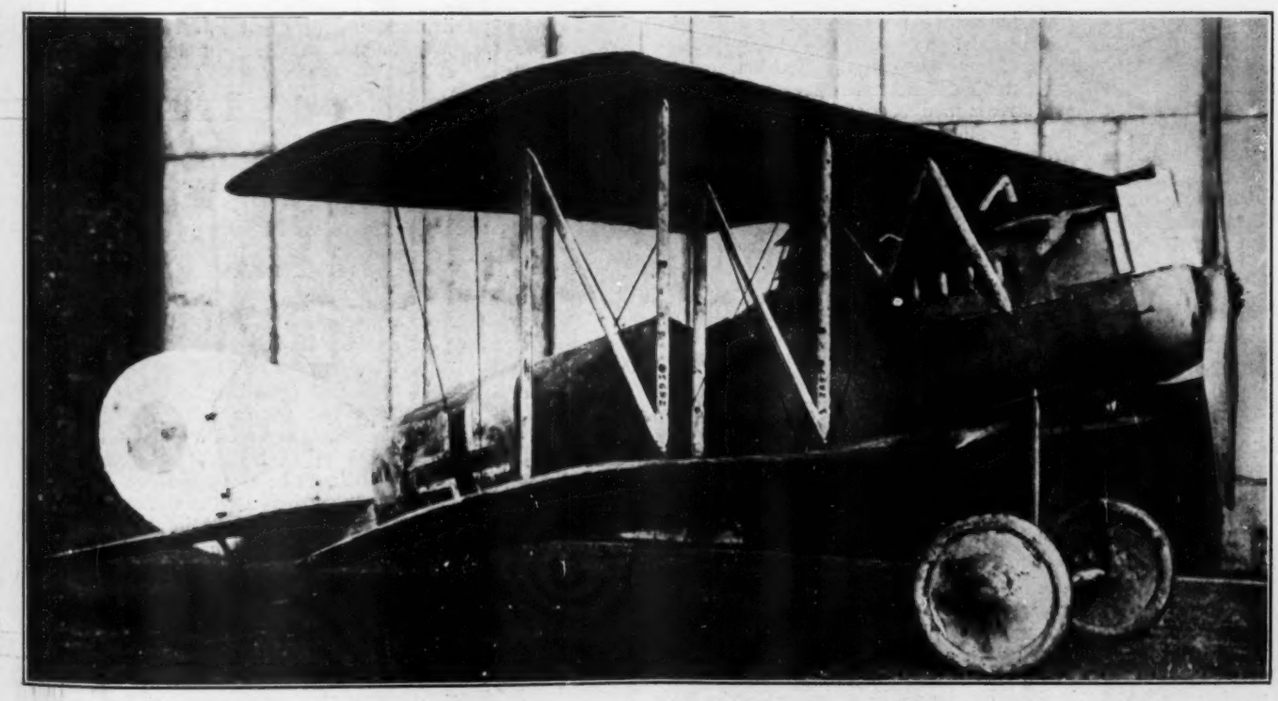
On June 1 observations covering a large part of the Angeles National Forest will be begun from a captive balloon stationed at about 3000 ft. over the Army Balloon School near Arcadia, Cal., and two routes of airplane patrol work will be operated from March Field, twelve miles southeast of Riverside, Cal. Two planes will be used on each route, the routes will each be approximately 100 miles long, and each route will be covered twice a day.

The airplane routes from March Field will afford an opportunity to survey about 2000 square miles in the Angeles and Cleveland National Forests. Fire warnings will be transmitted by means of parachute messages.

One of the interesting possibilities to be tested is bombing fires to put them out. It is believed that bombs charged with suitable chemicals can be used with good results.

The chief use of the aircraft this summer, however, will be for fire detection. At present the Forest Service relies for this partly on patrol, usually by men on horses, motorcycles, or railroad speeders, and partly on watchers stationed at lookout points. Aircraft have many points of obvious superiority for both classes of detection work. They would use wireless in reporting fires, as they have done in communicating with the artillery, and would locate fires by co-ordinates in the same way that gun fire in war is directed to a particular spot or object.

From the Army standpoint, the use of aircraft in protecting the National Forests affords a valuable opportunity for training fliers and developing further the possibilities of aircraft and the art of flying.



PFALZ SCOUT (160 HP. MERCEDES ENGINE) SURRENDERED TO THE ALLIES

(C) *Western Newspaper Union*

Veneer Body Construction

The development of veneer airplane bodies of the semi-monocoque type has been considerably delayed by lack of knowledge as to the best designs, materials and methods of construction, but not because of any unsuitability or insurmountable objections to this type of construction. The veneer construction is known to possess a number of important advantages over the truss type body, such as a considerably greater strength in proportion to weight—when properly made—and its suitability for streamlining. With regard to the latter property, a veneer body shows the greatest strength when made in proper streamlined section, whereas a truss type body in its strongest and simplest form is usually a square or parallelogram in section, and therefore requires special fairing elements for streamlining. Among other advantages may be mentioned that the veneer body will retain its alignment automatically and is not distorted by any load short of that corresponding to the elastic limit of the material —a condition which hardly ever occurs in service.

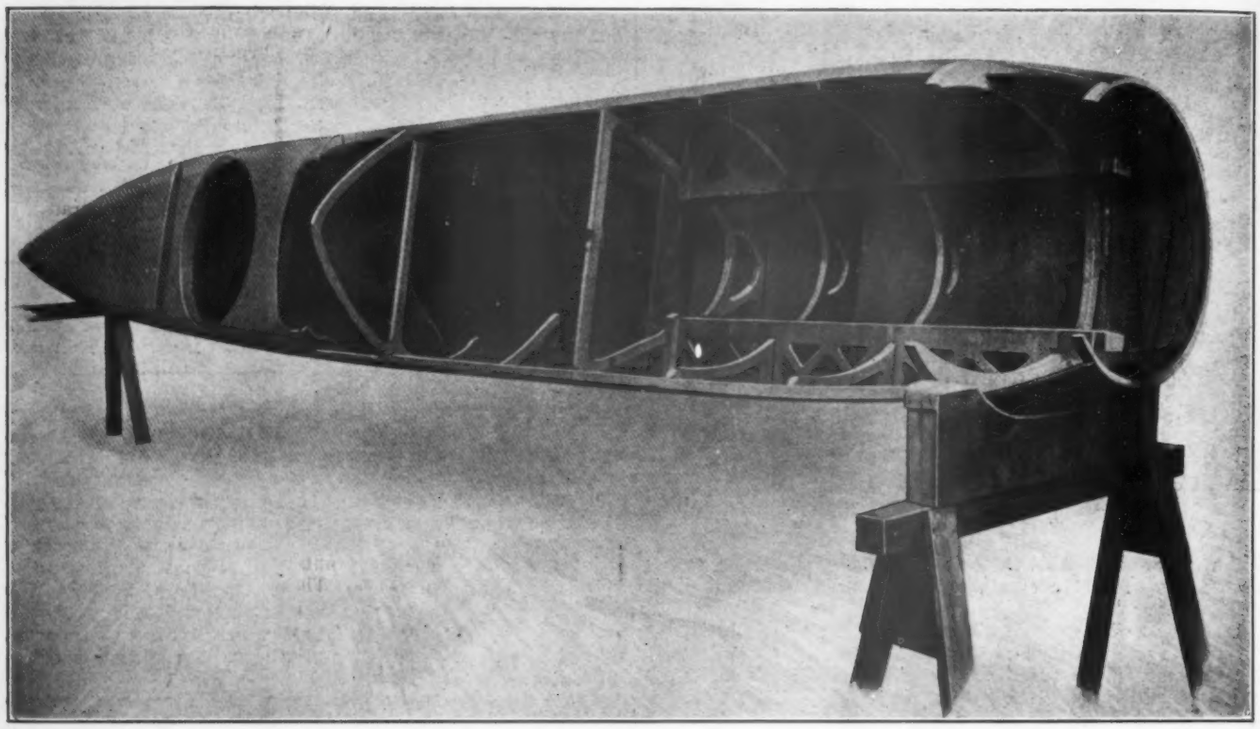


FIG. 1. TOP VIEW OF THE HASKELITE USC-1 FUSELAGE NO. 1 TYPE

The veneer construction also leads to a great reduction of timber wastage, since small pieces of wood, and even rejected pieces, may conveniently be worked into the veneer without weakening it. From the viewpoint of the constructor the veneer body offers quite a handsome proposition, because it involves fewer manufacturing operations, and requires many less fittings, which obviously simplifies assembly and speeds up production, while the repair of veneer bodies is a comparatively simple operation. Tests have been made at McCook Field on veneer bodies by cutting out sections of the bulkheads, and inserting new sections, gluing them into place and reinforcing with gusset plates both sides of the splice. These tests have shown these repaired sections to be fully as strong as the undamaged ones.

The veneer body, as here referred to, consists essentially of four longerons with bulkheads placed at suitable intervals, which skeleton is covered with a thin skin of veneered wood, glued and screwed to bulkheads and longerons. This "semi-monocoque" body is considered greatly superior to the true monocoque type, which is made without internal reinforcements in the form of longerons and bulkheads. The latter reinforce the whole body and permit the use of a comparatively light skin of veneer.

Tests were carried out and reported at McCook Field by Lieut. Alexander Klemin, A. S., in an endeavor to develop satisfactory veneer bodies for the USC-2 and USXB-1 combat planes. The results of these investigations, which are now available for publication, are of great interest because they are likely to straighten out many misconceptions which are still prevalent on this subject.

The following veneer bodies have been tested at McCook Field during the war:

For USC-2 two-seater combat airplanes, (a) Haskelite No. 1, (b) Haskelite No. 2, (c) Davies-Putnam, and (d) J. C. Widman Co. veneer bodies; for USXB-1 two-seater combat plane, (a) J. C. Widman Co., (b) Davies-Putnam No. 1, (c) Davies-Putnam No. 2, (d) Davies-Putnam No. 3 veneer bodies.

Tests of USC-2 Bodies

Haskelite USC-2 No. 1 Type—This veneer body had a skin of three-ply pressed to correct shape in four pieces by a special process. The face plies of the skin were of 1/28 in. birch with transverse grain, while the core was of 1/12 in. redwood with the grain longitudinal, making a total thickness when finished of ⅛ in. The weight was 6.0 oz. per sq. ft.

The longerons were of spruce, steamed and bent to shape, and the bulkheads were made up of Haskelite veneer, ranging from five-ply ⅜ in. in thickness to seventeen-ply of a total thickness of 1 in. The four sections of the skin were joined together at the longerons by means of butt joints, using nails and glue; in addition the skin was nailed and glued to each bulkhead with ⅝-in. No. 18 flat head cement-coated wire nails and Certus cold glue, respectively. The total weight of the body was 235 lb., apportioned as follows:

	Pounds.
Skin	80
Bulkheads	65
Longerons	41
Flooring	15
Engine bearers	22
Finish, including nails and glue	12
Total	235

In the first test of this body the fittings gave way at a load of 15 lb./sq. ft. (dynamic loading of 3) on the tail surfaces; upon the fitting being reinforced the test was continued until the body finally failed under a load of 17.5 lb./sq. ft. on the tail surfaces, a dynamic loading of 3.5.* The failure occurred first in the upper left longeron, which gave way in tension at a section through the pilot's cockpit. On examining the body afterwards, it was found that the veneer skin showed no signs of buckling anywhere, as the bulkheads had imparted sufficient stiffness to the structure to prevent this under the loads applied.

The strength of this body was considered hardly satisfactory as there was not enough tension bearing wood to withstand the load applied. Considering the whole structure as a shell in bending, it was found that under the load which produced failure the compression was 1510 lb./sq. in., and the tension 3430 lb./sq. in. Test in tension on the veneer skin showed average values of 5500 lb./sq. in.; the spruce longerons probably had a tensile strength of 7000 to 8000 lb./sq. in.

In conclusion it may be said that the bulkheads stiffened the body adequately, but that the lower longerons were much stronger than required, while the upper longerons should have been heavier at the cut-outs, such as at the pilot cockpit where they were routed, whereas they should have been left solid. More tension material should also have been provided by running most of the wood in the skin with the grain longitudinally instead of tranversely.

Haskelite USC-2 No. 2 Type—The general construction of this body was similar to No. 1, just mentioned, but several improvements were made in the details of the framework. The bottom longerons were of three-ply laminated birch, while the top fore and aft members were built up of laminated birch and ash. The bulkheads were of laminated ash, with the grain in all plies circumferential, and were steam-bent. These ribs were used throughout the tail portion of the body (Fig. 1).

The skin was of three-ply wood, the face being of birch 1/28 in. thick with the grain circumferential, and the core 1/28 in. thick mahogany with longitudinal grain. Finished, the total thickness was 3/32 in. The body weighed 200 lb. complete, apportioned as follows:

	Pounds.
Longerons	31
Bulkheads	46
Skin	70
Engine bearers	13
Flooring	15
Stringers, seat bearings, etc.	10
Finish, including nails and glue	15
Total	200

The tests on this body revealed a series of weaknesses. The first to develop was incidental to the manufacture of the body, the skin at station 8 pulling away from the bulkhead under a dynamic loading of 3 and a load of 15 lb./sq. in. on the tail surfaces, but this failure was probably due to improper manufacture and not to faulty design.

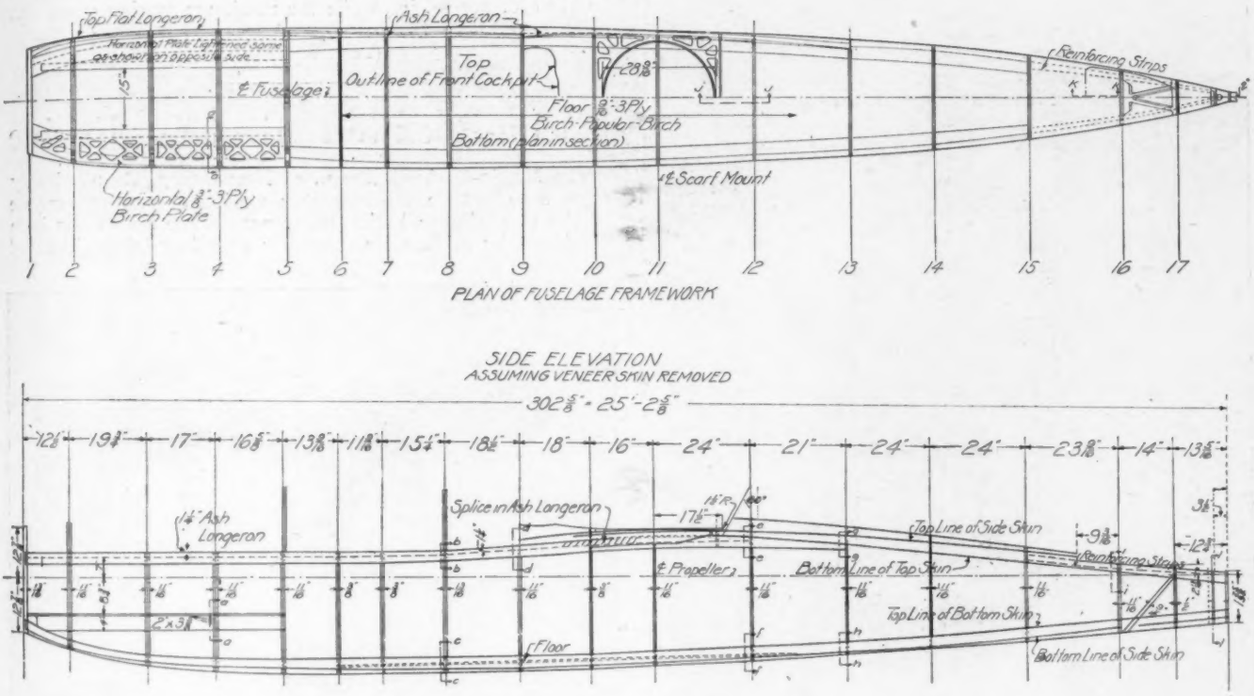

Top Flat Longeron
Ash Longeron
Reinforcing Strips
Outline of Front Cockpit
Floor 3/8" 3 Ply Birch-Poplar-Birch
Bottom (plan in section)
Scarf Mount
Horizontal 3/8" 3 Ply Birch Plate
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
PLAN OF FUSELAGE FRAMEWORK
SIDE ELEVATION
ASSUMING VENEER SKIN REMOVED
302 5/8" - 25'-2 5/8"
Splice in Ash Longeron
Top Line of Side Skin
Bottom Line of Top Skin
Top Line of Bottom Skin
Bottom Line of Side Skin
Floor

FIG. 2. DIAGRAM OF HASKELITE USC-2 FUSELAGE NO. 2 TYPE

After proper reinforcement at this point complete failure occurred under a dynamic load of 3½ by the crumpling of the skin at the under side, due to the absence of longerons in the rear portion of the body. This test confirmed the conclusion reached in the testing of No. 1 body, namely, that the bulk of the grain in veneer should run longitudinally, and brought out the necessity for rather stiff longerons to provide for sufficient fore-and-aft strength.

Davies-Putnam USC-2 Type—In this body each veneer plate for the skin was bent to the proper curvature before being fastened to the bulkheads, which was accomplished by boiling the veneer and pressing it onto molds where it was fastened until thoroughly dried. The framework was composed of four spruce longerons, rectangular in cross section at points of attachment to the bulkheads, and tapering from 2 x 2 in. in the middle portion to 1 x 1½ in. towards front and rear. The lower longerons were routed to L-section in the middle portion and to T-section between bulkheads forward and aft. The upper longerons were similarly routed except that the L-section extended from station 1 to 10, whence they were left solid up to station 12, and changed into T-section up to the tail.

The bulkheads were of plywood, the number of laminations ranging from five to seventeen and the total thickness from 7/16 to 1 in. The three-ply veneer skin used was made with face plies of 1/28 in. mahogany with the grain running transversely, while the core was of 1/12 in. poplar with longitudinal grain. The veneer skin was glued and nailed to longitudinals and bulkheads.

* "Dynamic loading" is the amount by which the component parts of an airplane are multiplied under the action of centrifugal or other dynamic forces. Thus a dynamic factor of 5 at failure signifies that the breakage load was five times the weight of the airplane plus an air load of 25 lb. per sq. ft. applied on the horizontal tail surfaces. It would be incorrect to say that this represented a "safety factor" of 5, as in all probability the factor of safety over extreme conditions is no more than unity, and in some cases may even be less.

The total weight of this body was 185 lb. 1 oz., apportioned as follows:

Longerons	27 lb.
Engine bearers	13 lb.
Skin, including nails	66 lb.
Bulkheads	49 lb.
Stringers	4 lb. 8 oz.
Flooring	13 lb.
Finish	12 lb. 9 oz.
Total	185 lb. 1 oz.

This body failed under a dynamic loading of 4 by giving way over the point of support located at the attachment for the rear lift wire (Fig. 3). This failure was due to the fact

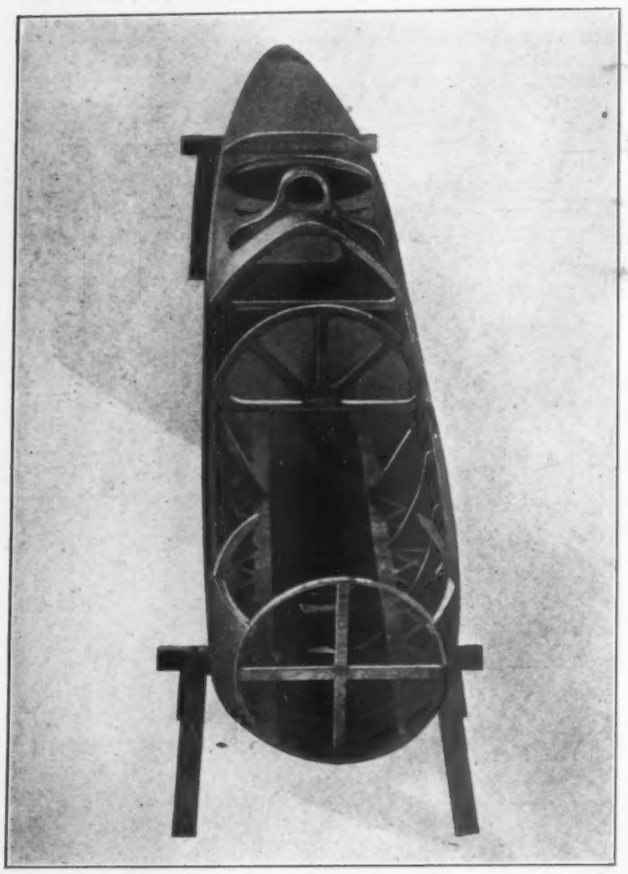


FIG. 3. WIDMAN USC-2 TYPE FUSELAGE

that the very large reactions at the point of failure do not coincide with the line of vertical support at the longerons, which results in a cantilever action about the point of support and the consequent pulling away of the bulkhead. It is considered advisable to omit lightening holes in a bulkhead of this type.

Widman USC-2 Type—This veneer body was similar in outline and general construction to the three preceding ones, but the process of construction was much more simple. An important step was taken in the right direction by making the face plies of the skin of 1/28 in. mahogany with the grain longitudinal, while the core was 1/20 in. poplar with the grain transverse. The total thickness of this skin, after being pressed and sanded, was 3/32 in. and the weight was 3.6 oz. per sq. ft. The bulkheads were built up of alternate plies of $\frac{1}{16}$ in. birch and poplar. All joints were glued and secured by brass screws.

The total weight of this body was 182 lb., made up as follows:

	Pounds.
Longerons	27
Skin	46
Engine bearers and front bulkheads	52
Remaining bulkheads	33
Flooring	10
Screws and finish	14
Total	182

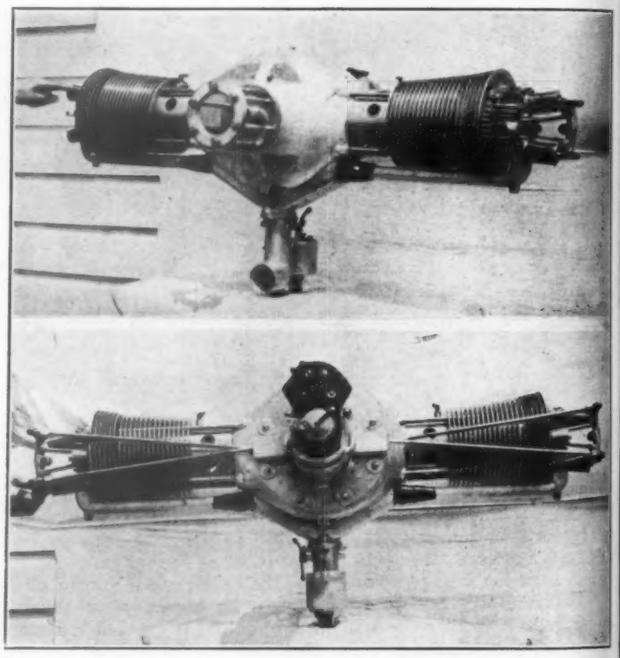
This body was supported, for the test, on a padded frame, instead of being suspended from the lift wire attachments. It withstood a factor of 3, but at this loading the skin on the bottom showed a tendency to buckle on account of compression. On the addition of the next load the upper right longeron failed in shear forward of a bulkhead and the butt joint at this point gave way in tension, while the plywood bulkhead, which was connected to the two sides of this joint pulled apart.

Despite several errors made in its manufacture, such as the use of butt joints at positions of great stress and the sanding down of the outer ply of the skin, this body stood up well under the test and bore out the importance of having most of the grain in the skin run longitudinally. Another lesson learned was that it is inadvisable to provide too much compression area in the lower longerons, and that where a cockpit cut-out is present sufficient tension bearing material must be supplied nearby. The maximum compression stress was found to be 1930 lb. per sq. in., while the maximum tension stress was 5500 lb. per sq. in.

(To be concluded)

Marlin-Rockwell Airplane Engine

The Marlin-Rockwell Corp., of New Haven, Conn., shortly expects to put on the market a stationary airplane engine of the two-cylinder horizontal opposed type which has been developed by J. L. Cato, formerly experimental engineer of



THE MARLIN-ROCKWELL ENGINE

the L-W-F Engineering Corp., and is illustrated herewith in front and rear views.

This engine, which has been designed for use in a small sporting monoplane now being developed by Mr. Cato, has in its initial tests given 72 hp. at 1,825 r.p.m., and weighs well under 2 lb. per hp. Mr. Cato also intends to develop the same design into a 10-cyl. radial engine which is to develop 500 hp. and weigh about 1½ lb. per hp.

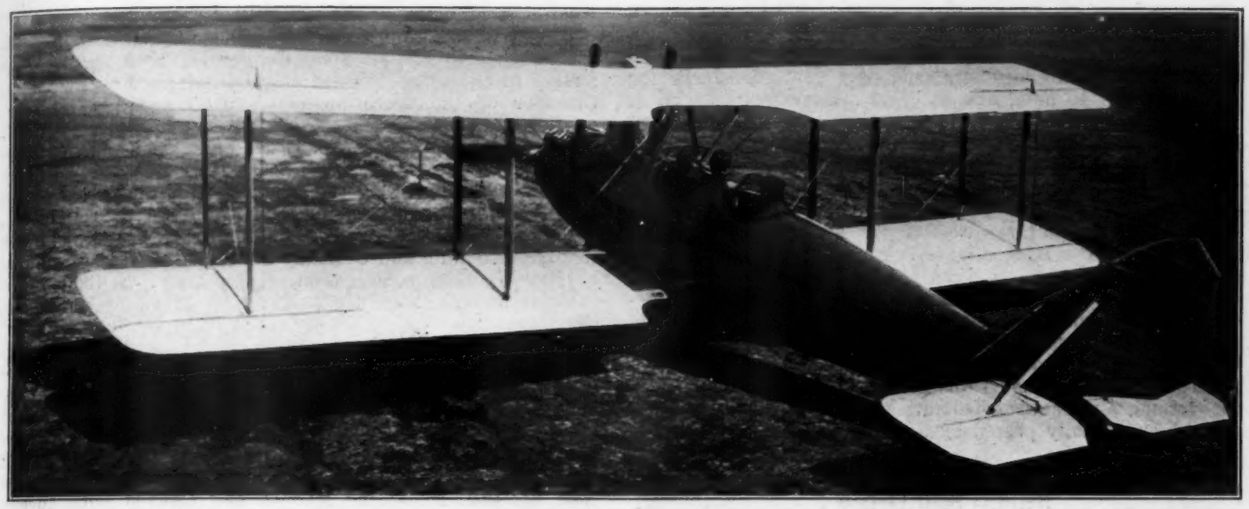
Air Service Equipment Sold

Sales reported to the Office of the Director of Sales include the following Air Service equipment:

Airplanes	$319,000
Airplane equipment	679,887

These machines are L. W. F. equipment sold to the Czecho-Slovak Government.

The Curtiss-Oriole Transport Airplane



Immediately after the signing of the armistice the Curtiss Aeroplane and Motor Corp. directed the energies of its designers toward the development of aircraft designed to meet the demand of aerial transport. As a result, G. L. Gilmore, airplane engineer for the Curtiss Engineering Corp. at Garden City, L. I., designed the Oriole, a three-seater biplane developed primarily with a view to afford comfort to aerial travellers.

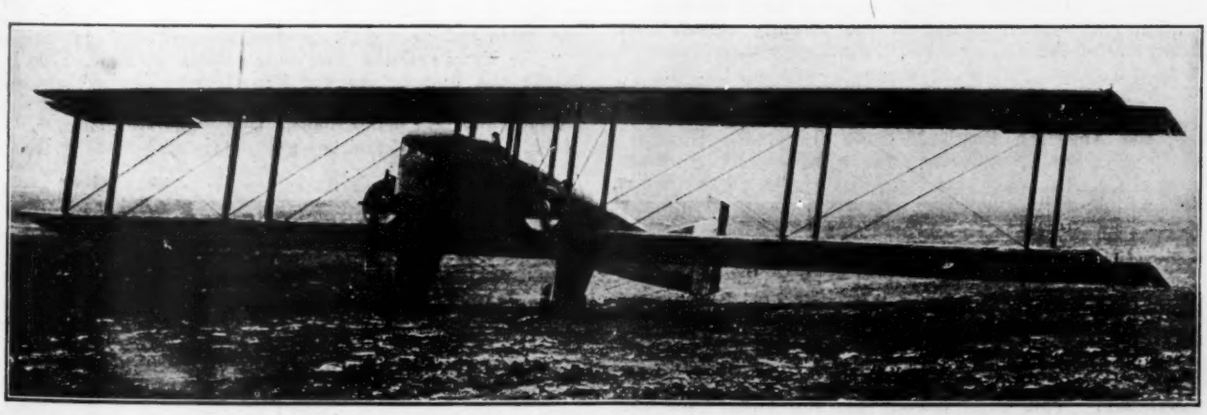
The Oriole has a span of 36 ft., an overall length of 25 ft., and an overall height of 9 ft. 5 in. The fuselage is built up of special plywood, in two parts and connected on the center line, with fore and aft stringers acting as stiffening members; there are no bulkheads, the construction being of the monocoque type. The body is elliptical in cross-section, and is painted orange, while the wings are yellow and black; the machine thus follows the color scheme of the oriole, after which it is named.

The power plant consists of a Curtiss OX-5 8-cyl., 90 hp. watercooled engine, driving a tractor propeller. It is equipped with a self-starter.

Two cockpits are provided, one forward seating two passengers in luxurious accomodations, and one aft seating the pilot. The position of the cockpits and a wide cutout in both planes gives passengers and pilot a clear visual range in flight, while windshields protect them from the air thrown back by the propeller.

The machine weighs fully loaded 2,188 lb., and carries a useful load of 767 lb. The high speed is 85 m.p.h., and the landing speed 40 m.p.h.

The Farman Goliath Transport Airplane



The Farman Goliath transport airplane, a converted bomber originally designed by the French Air Service, recently made a series of notable flights.

On Feb. 8 the Goliath carried, beside its two pilots, twelve passengers from Paris to London and return, covering the distance of 240 miles in 2 hr. 40 min. on the outward trip, and in 3 hr. 10 min. on the return voyage.

On Feb. 11 the Goliath flew with fourteen passengers from Paris to Brussels and return. The distance of 187 miles was covered in 3 hr. 11 min., and 2 hr. 56 min., respectively. Following this flight the Belgian government authorized, on Feb. 26, the establishment of a regular aerial passenger service between Brussels and Paris, which will operate with a fleet of ten Goliaths. The price of the journey, which includes a life insurance for $20,000, is to be $60, that is 31 cents per mile. It is intended to eventually link up this service with lines to be run between Amsterdam, Antwerp, Lille, Paris, Bordeaux and Nice.

On April 1 the Goliath reached an altitude of 20,000 ft. with a pilot, four passengers and ballast representing eight others.

The Farman Goliath is a twin-tractor biplane of 92 ft. span, which is fitted with two 250 h.p. Salmson engines, and has a high speed at ground level of about 110 m. p. h. Accommodations are provided for the passengers in the form of wicker chairs, placed in two rooms in the body; the body is heated by radiators utilizing the exhaust gases.

News of the Fortnight

F-5-L Seaplane in 20-Hr. Flight

The United States naval seaplane No. 3589, F-5-L type, established on April 25-26 a new endurance record for American heavier-than-air craft by remaining continuously in the air for 20 hr. 10 min., and covering a distance estimated at 1,250 miles. The flight was made at an average altitude of 3,000 ft. in a closed circuit off Hampton naval air station. The crew consisted of Lieutenant-Commander Grow, U.S.N., and Ensign Thomas, pilots, and Ensigns Souther and Irvine, observers.

The world's endurance record for heavier-than-air craft recognized by the International Aeronautical Federation was established on June 26-27, 1914, by the German A. Landmann on an Albatross biplane equipped with a 100 hp. Mercedes engine by remaining in the air 21 hr. 48 min. 45 sec. On July 11, 1914, the German Reinhold Boehm, flying a machine of the same type, remained in the air over Johannisthal aerodrome for 24 hr. 12 min.; this record, which is recognized by the German Aeronautical Federation as the world's record, has never been officially passed by the International Aeronautical Federation.

Britons Still Delayed

When this issue of AVIATION went to press bad flying weather prevailed off the coast of Newfoundland, and the British trans-Atlantic machines still remained in their hangars.

There have been eight entries in the London *Daily Mail* $50,000 competition, all of which are British design and construction except the one to be used by Captain Sundstedt, which is being rebuilt by the Whittemann-Lewis Aircraft Corp. of Newark, N. J. They are:

F. Raynham, Martinsyde	285 hp.,	100 m.p.h.
S. Pickles, Fairey	375 hp.,	120 m.p.h.
Major J. C. P. Wood, Short	350 hp.,	95 m.p.h.
H. G. Hawker, Sopwith	350 hp.,	100 m.p.h.
Capt. A. Payse, Whitehead	1600 hp.,	115 m.p.h.
Capt. Sydney Bennett, Handley Page	1500 hp	.....
J. A. Peters, Alliance	450 hp.,	100 m.p.h.
Capt. H. Sundstedt, Seaplane	440 hp.	.....
Col. J. C. Porte, "Felixtowe Fury"	1875 hp.	.....

Magneto Educational Campaign

A comprehensive and far-reaching plan for a co-operative educational advertising campaign was recently agreed upon between five of the leading American magneto manufacturers, at a meeting arranged by the Wales Advertising Co.

Solely for the purpose of acquainting users of automotive apparatus with the merits of the magneto for ignition purposes, the American Bosch Magneto Corp., the Eisemann Magneto Co., the Ericeson Manufacturing Co., the Splitdorf Electrical Co. and the Simms Magneto Co., have combined to carry out this educational plan. There is no organization or amalgamation of interests otherwise, nor will this arrangement interfere in any way with the regular advertising or general business of each individual company.

Second Trans-Andean Flight

A recent telegram from Chile announced that Lieutenant Cortinez has crossed the Andes at an altitude of 6,000 metres (19,600 feet). This is the second time the Andes have been crossed by airplane, both crossings were made on British-built Bristol machines.

United Aircraft Expanding

F. G. Diffin, President of the United Aircraft Engineering Corp., 52 Vanderbilt Ave., New York, announces the appointment of Lynn V. Blankman as Manager of the Central West territory. Offices have been opened at 514 Westminster Building, Monroe and Dearborn Sts., Chicago, Illinois.

Mr. Blankman brings to his new position a wide and varied experience in aeronautics together with a knowledge of conditions in this territory.

Akron Starts Airship Campaign

A movement to arouse interest throughout the United States with a view to prevail upon Congress to adopt a vigorous airship program for America has been launched by the Akron Chamber of Commerce upon recommendation by its aeronautics committee, which consists of Don R. Stevens, A. W. Burnett, George H. Kile, W. E. Duersten and John R. Gammeter. A circular letter has been sent by this body to every chamber of commerce in the country, calling attention to the fact—which was editorially commented upon in the Feb. 1, 1919, issue of AVIATION AND AERONAUTICAL ENGINEERING—that Great Britain and Germany are already far ahead of this country in airship construction, and inviting them to join in a national movement for the building up of an American airship fleet.

Excerpts from this letter are printed herewith:

"In the United States comparatively few civilians have come to realize as yet that the day of commerce of the air by airship and airplane has arrived and that already Great Britain is found in the familiar shipping position leading all competitors in the construction of dirigible airships and with plans for tying together her vast empire including Australia, New Zealand, India, the Africas and Canada with speedy straight line air service using airships of mammoth size and capable of carrying many tons of mail, cargo and passengers. Germany, in fact, is far from asleep on this project and her constructors are busy today improving and building giant Zeppelins and preparing them for immediate use in competition for world commerce.

"One has only to study the plans of the British Air Ministry as presented through the London press and to note the vast appropriations of Government funds that are being made in the face of an extremely burdensome war debt to realize that England means business in setting out for the supremacy in the commercial air business. It is but natural and proper therefore that Akron, with her knowledge of the possibilities of the airship, should call attention to these facts and enlist the support of other influential American business bodies to awaken Congress to the real situation.

"The construction of monster airships is too big a problem for any one corporation to finance. The problem can only be met through proper appropriation of government funds used to subsidize American industry under Governmental supervision. This is the method in use in England. Funds are needed here for the design and construction of ships, landing fields and mammoth construction and docking facilities.

"The Navy and the Army air officers naturally have been among the first to see the immediate need for improving America's position and they already have had many conferences and laid many plans. Unfortunately, however, Congress has adjourned and left these plans high and dry for lack of appropriations.

"America has no commercial airship today, nothing but a few small ships incapable of trans-Atlantic flight and incapable of carrying more than a few passengers on any flight. America has no docking facilities for big ships. England is ready today with a dirigible which will soon attempt to cross the Atlantic and will probably return without stopping here for lack of docking facilities in America. A real demonstration."

Atlantic City Meet

The second Pan-American Aerial Congress opened at Atlantic City, N. J., May 1.

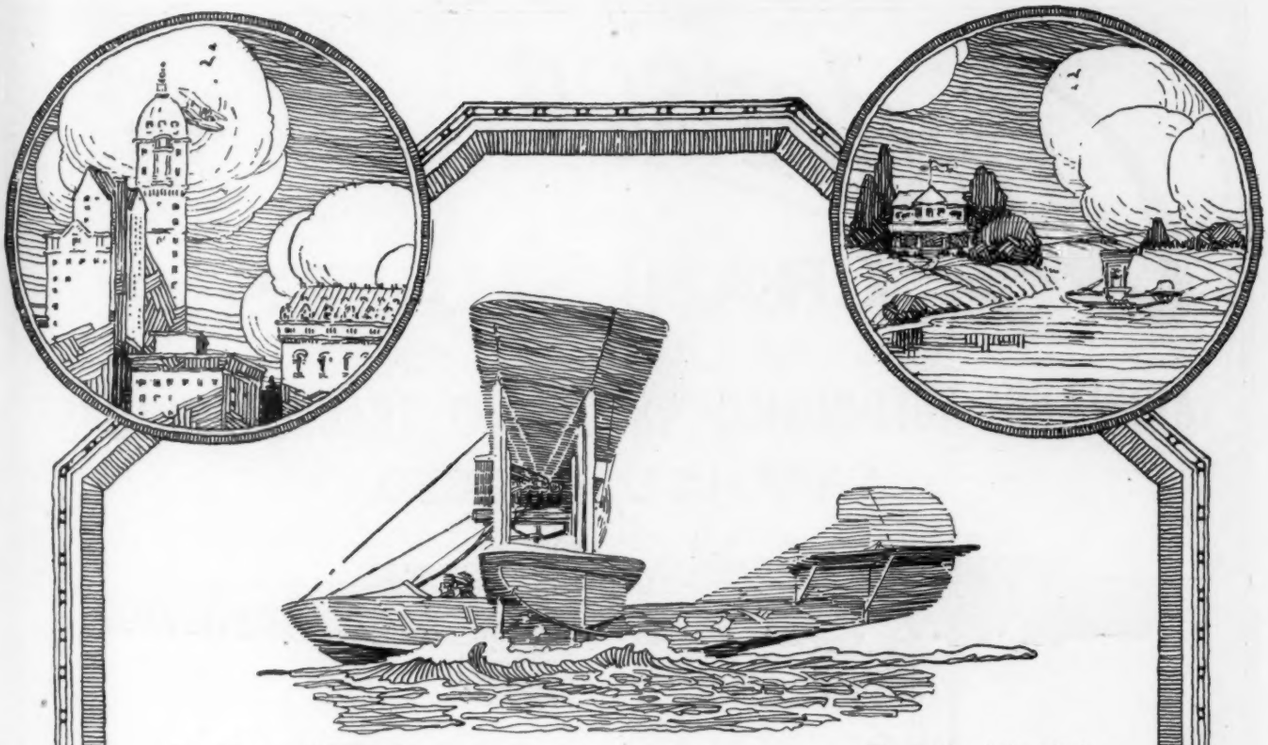
Among the prize winners thus far are:

First arrival ($500)—Roland Rolff in the Oriole, built by the Curtiss Aeroplane & Motor Corp. Distance 120 miles.

Second arrival ($250)—Eddie Stinson in JN-4 equipped with a Curtiss OX 90 hp. engine.

Seaplane flight from Atlantic City to New York and return ($500)—E. K. Jaquith, first, in a 90 hp. Curtiss M F boat; Beryl H. Kendrick, second ($250), same style machine.

Intercollegiate seaplane race, thirty miles ($250 expense money), S. Raymond Beckwith, University of Pennsylvania, first, in a Curtiss boat; Ensign M. S. Martin, Columbia, second; A. Post, Amherst, third.



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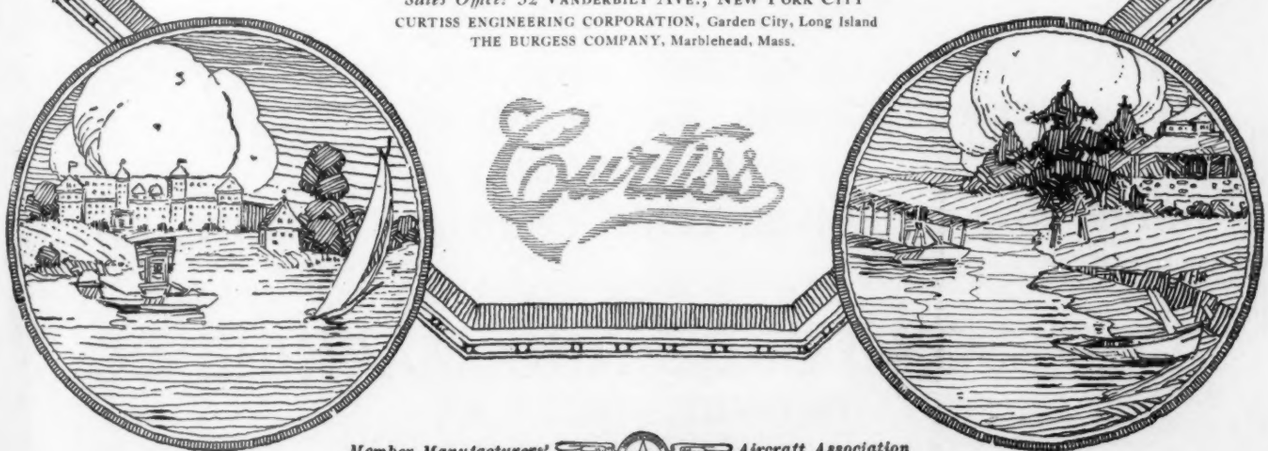

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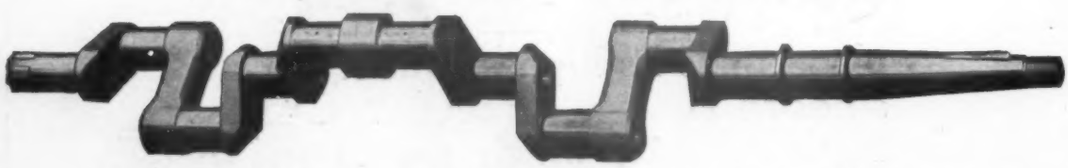

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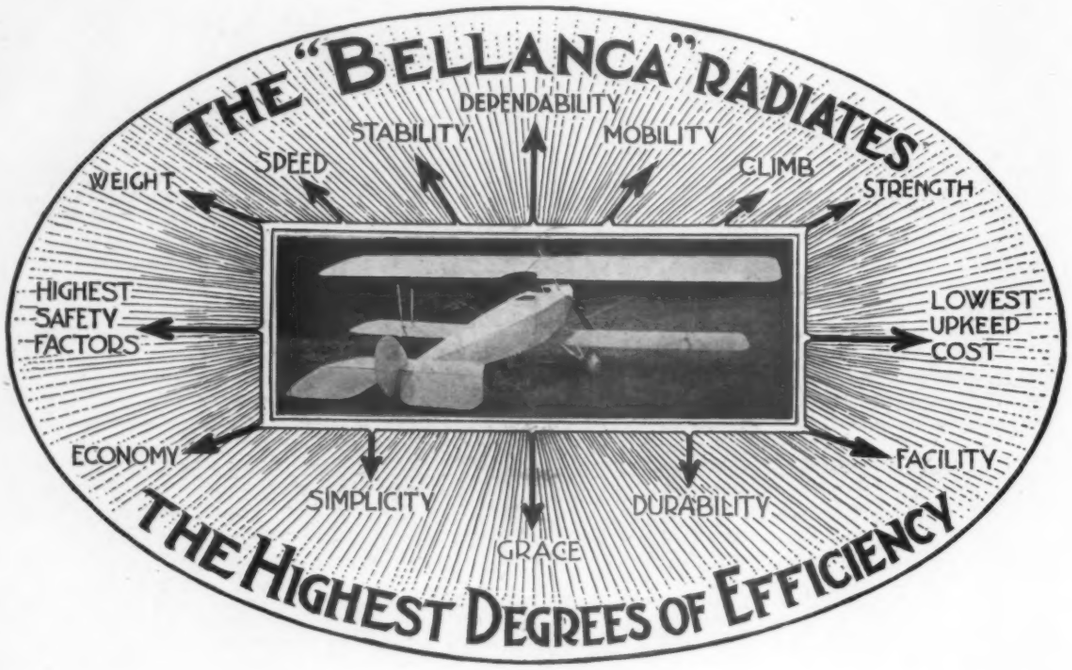

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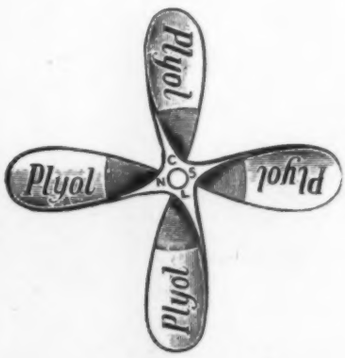

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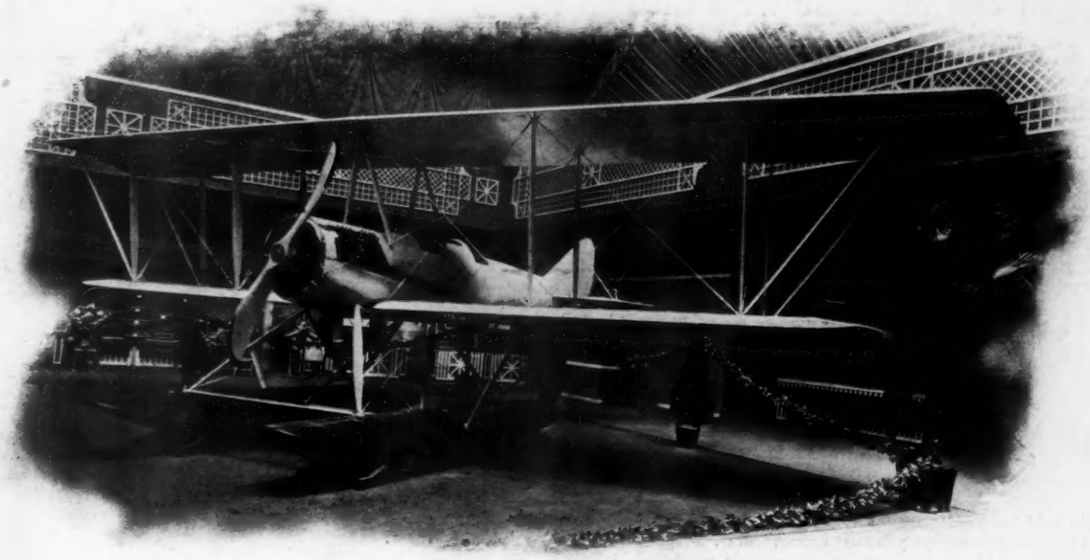

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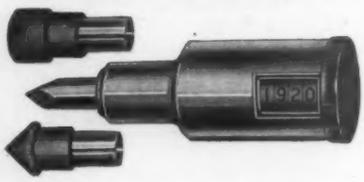

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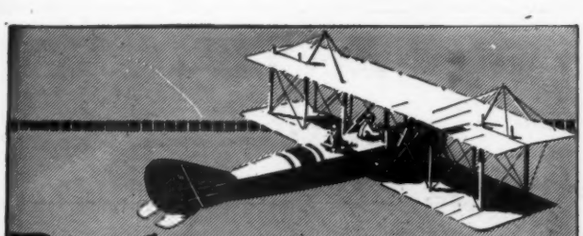

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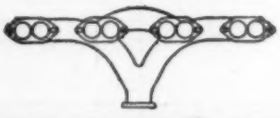

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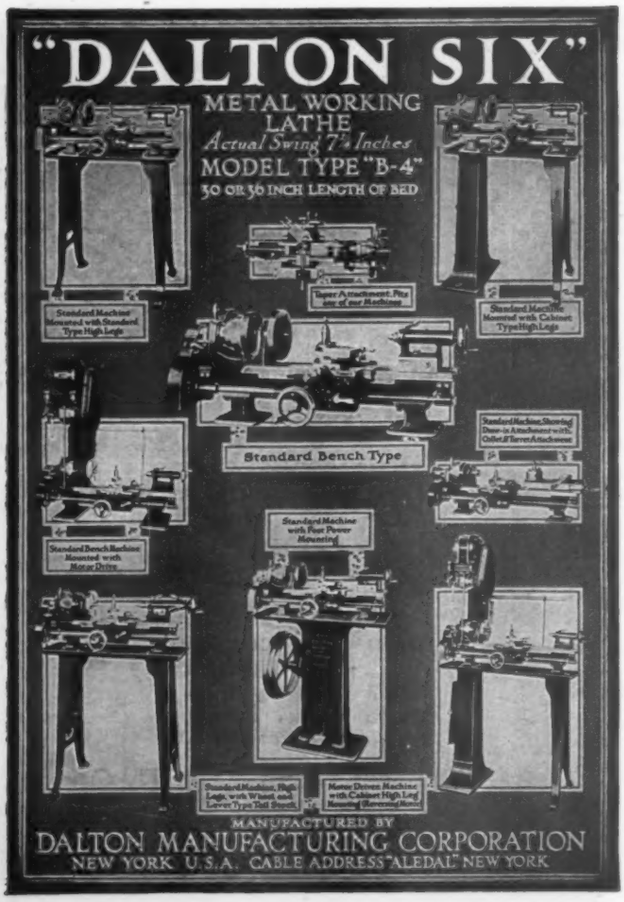

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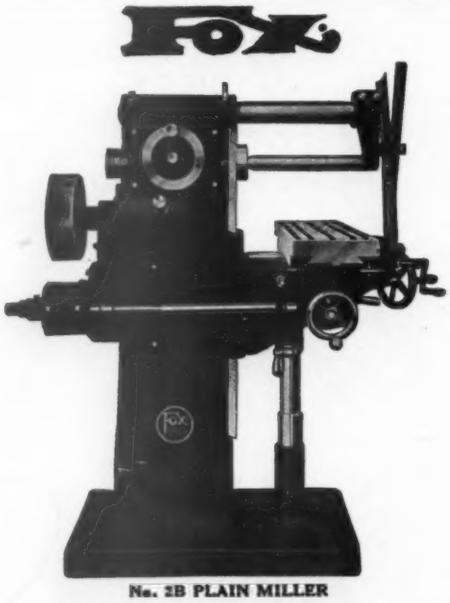

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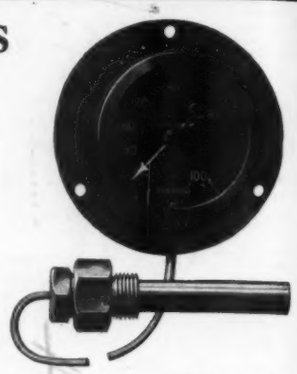

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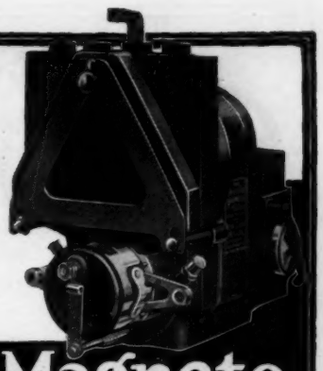

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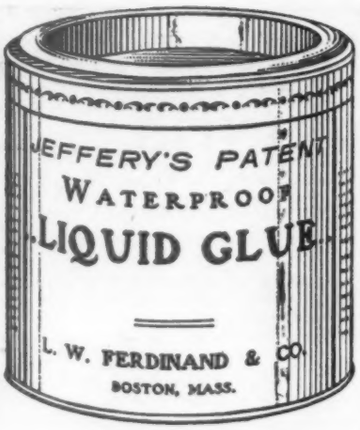

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